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THE ECONOMIC OUTLOOK—PRESENT AND PROSPECTIVE.

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PART II.

THE causes of the almost universal discontent of labor, which has characterized the recent transitions in the world's methods of production and distribution, and which, intensified by such transitions, have been more productive of disturbances than at any former period, (for, as previously shown, there are really no new factors concerned in the experiences under consideration), would seem to be mainly these:

1. *The displacement or supplanting of labor through more economical and effective methods of production and distribution.*

2. *Changes in the character or nature of employments consequent upon the introduction of new methods—machinery or processes—which in turn, it is claimed, have tended to lower the grade of labor, impair the independence and restrict the mental development of the laborer.*

3. *The increase in intelligence, or general information, on the part of the masses, in all civilized countries.*

To a review of the character and influence of these several causes, separately and in detail, attention is next invited.

And, *first*, as to the extent and influence of the displacement of labor through more economic and effective methods of production and distribution. Of the injury thus occasioned, and of the suffering attendant, no more pitiful and instructive example of recent date could be given, than the following account, furnished to the United States Department of State,* of the effect of the displacement of hand-loom weaving in the city of Chemnitz, Saxony, by the introduction and use of the power-loom:

* Report of United States Consul George C. Tanner, Chemnitz, December, 1886.

In 1875 there were no less than 4,519 of the so-called "*master-weavers*" in Chemnitz, each of whom employed from one to ten journeymen at hand-loom weaving in their own houses. The introduction of machinery, however, imposed conditions upon these weavers which they found the more difficult to meet the more the machinery was improved. The plainer goods were made on power-looms, and work in the factories was found to be more remunerative. Instead of giving work to others, they were gradually compelled to seek work for themselves. The independent "master" soon fell into ranks with the dependent factory-hand, but as he grew older and his eyesight failed him he was replaced by younger and more active hands, and what once promised to become a well-to-do citizen in his old age now bids fair to become a burden upon the community. Those who had means of procuring the newer Jacquard contrivance, or even the improved "leaf" or "shaft-looms," managed to eke out a subsistence; but the prospects of the weavers who have learned to work only with the hand-looms are becoming more hopeless every day.

Now, while such cases of displacement of labor appeal most strongly to human sympathy, and pre-eminently constitute a field for individual or societary action for the purpose of relief, it should be at the same time remembered that the world, especially during the last century, has had a large experience in such matters, and that the following points may be regarded as established beyond the possibility of contravention: 1. That such phases of human suffering are now, always have been, and undoubtedly always will be, the inevitable concomitants of the progress of civilization, or the transitions of the life of society to a higher and better stage. They seem to be in the nature of "growing-pains," or of penalty which Nature exacts at the outset, but for once only, whenever mankind subordinates her forces in greater degree to its own will and uses. 2. That it is not within the power of statute enactment to arrest such transitions, even when a large and immediate amount of human suffering can certainly be predicated as their consequent, except so far as it initiates and favors a return of society toward barbarism; for the whole progress in civilization consists in accomplishing greater or better results with the same or lesser effort, physical or mental. 3. All experience shows that, whatever of disadvantage or detriment the introduction and use of new and improved instrumentalities or methods of production and distribution may temporarily entail on individuals or classes, the ultimate result is always an almost immeasurable degree of increased good to mankind in general. In illustration and proof of this, attention is asked to the following selection from the record of a great number of well-ascertained and pertinent experiences:

The invention of the various machines which culminated in the knitting or weaving of stockings by machinery in place of by hand, occasioned great disturbances about the commencement of the present century among a large body of operatives in the counties of Leicester and Nottingham, in England, who had been educated to old methods of stocking-making and were dependent upon the continued prose-

cution of them for their immediate livelihood. The new stocking-frames as they were introduced were accordingly destroyed by the handicraft workmen as opportunity favored (over one thousand in a single burst of popular fury), houses were burned, the inventors were threatened and obliged to fly for their lives, and order was not finally restored until the military had been called out and the leading rioters had been arrested and either hanged or transported. Looking back over the many years that have elapsed since this special labor disturbance (one of the most notable in history), the first impulse is to wonder at and condemn what now seems to have been extraordinary folly and wrong on the part of the masses, in attempting to prevent by acts of violence the supersedure of manual labor engaged in making stockings through the introduction and use of ingenious stocking-making machinery. But, on the other hand, when one remembers the number of persons who, with very limited opportunity for any diversity of their industry, and with the low social and mental development incident to the period, found themselves all at once and through no fault of their own deprived of the means of subsistence for themselves and their families, and are further told by the historian of the period* that, from the hunger and misery entailed by this whole series of events, the larger portion of fifty thousand English stocking-knitters and their families did not fully emerge during the next forty years, there is a good deal to be set down to and pardoned on account of average human nature. The ultimate result of the change in the method of making stockings and its accompanying suffering has, however, unquestionably been that for every one person poorly fed, poorly paid, badly clothed, and miserably housed, who at the commencement of the present century was engaged in making stockings on hand-looms or in preparing the materials out of which stockings could be made, ten at least are probably now so employed for a third less number of hours per week, at from three to seven times greater average wages, and living under conditions of comfort that their predecessors could hardly have even anticipated.†

In strong contrast also with the report of the pitiful distress of the displaced hand-loom weavers of Saxony comes this other statement from many sources: That in all the great manufacturing centers of Germany, and especially in the cities of Chemnitz (where the hand-looms are being rapidly displaced), in Crefeld, Essen, and in Düssel-

* "History of the Machine-wrought Hosiery Manufactures," by William Felkin, Cambridge, England, 1867.

† The wages of the stocking-knitters in Leicestershire in the early years of this century were among the very lowest paid in any branch of industry in Great Britain, and did not exceed on an average six shillings a week. In 1880 the wages paid first-class operatives (men) in the hosiery-factory of the late A. T. Stewart, at Nottingham, England, were 44*s.* 5*d.* per week, and for girls of similar capabilities 16*s.* 6*d.* Within more recent years further improvements in machinery, by creating a disproportion between the supply of the labor of framework-knitters and the demand for it, has again greatly disturbed the condition of the work-people in this branch of industry in England.

dorf, the standard of living and of comfort among the masses is far higher than at any former period. Writing from Mayence under date of January, 1887, United States Commercial Agent J. H. Smith reports that, "although business is in an unsatisfactory state, it does not seem to affect the workingman greatly. Wages remain pretty much the same, and few discharges of hands take place. The stagnant state of the market only serves to make the necessaries of life cheaper, and to enhance the purchasing power of the laborer's money." United States Consul-General Raine, at Berlin, during the same month, also reported that "wages in Germany show a rising tendency"; that workingmen with permanent work, and wages unchanged, are deriving marked advantages from the low prices of provisions; and that, although the population of Germany has experienced an increase of three millions since 1879, "no lack of work was noticeable."

The readiness with which society comprehends the suffering contingent on the relentless displacement of labor by more economical and effective methods of production and distribution, and the overmastering feelings of sympathy for individual distress thereby occasioned, causes it to generally overlook another exceedingly interesting and important involved factor, and that is the relentless impartiality with which the destructive influences of material progress coincidently affect capital (property) as well as labor. It seems to be in the nature of a natural law that no advanced stage of civilization can be reached except at the expense of destroying in a greater or less degree the value of the instrumentalities by which all previous attainments have been effected. Society proffers its highest honors and rewards to its inventors and discoverers; but, as a matter of fact, what each inventor or discoverer is unconsciously trying to do is to destroy property, and his measure of success and reward is always proportioned to the degree to which he effects such destruction. If to-morrow it should be announced that some one had so improved the machinery of cotton-manufacture that ten per cent more of fiber could be spun and woven in a given time with no greater, or a less expenditure of labor and capital than heretofore, all the existing machinery in all the cotton-mills of the world, representing an investment of millions upon millions of dollars, would be worth little more than so much old iron, steel, and copper; and the man who should endeavor to resist that change would, in face of the fierce competition of the world, soon find himself bankrupt and without capital. In short, all material progress is effected by a displacement of capital equally with that of labor; and nothing marks the rate of such progress more clearly than the rapidity with which such displacements occur. There is, however, this difference between the two factors involved. Labor displaced, as a condition of progress, will be eventually absorbed in other occupations; but capital displaced, in the sense of substituting the new for what is old, is practically destroyed.

It has previously been pointed out that the great and signal result of the recent extraordinary material progress, has been to increase the abundance and reduce the price of most useful and desirable commodities. But this statement applies to capital, as a commodity, in common with other commodities; and here comes in another very significant and, from a humanitarian point of view, a most important result, or perhaps rather a "law" (pointed out years ago by Bastiat, and in proof of which evidence will be presently submitted), that, "in proportion to the increase of capital, the relative share of the total product falling to the capitalist is diminished, while, on the contrary, the laborer's share is relatively increased. At the same time all progress, from scarcity to abundance, tends to increase also the absolute share of product to both capitalist and laborer, inasmuch as there is more to divide."

Again, it is a singular anomaly, that while an increasing cost of labor has been the greatest stimulant to the invention and introduction of labor-saving machinery, labor employed in connection with such machinery generally commands a better price than it was able to do when similar results were effected by more imperfect and less economical methods. Perhaps the most remarkable illustration of this is to be found in the experience of the American manufacture of flint-glass, in which a reduction, since 1870, of from 70 to 80 per cent in the market price of such articles of glass table-ware as goblets, tumblers, wine-glasses, bowls, lamps, and the like, consequent upon the adoption of methods greatly economizing labor and improving quality, has been accompanied by an increase of from 70 to 100 per cent in wages, with a considerable reduction in the hours of labor.* M. Poulin, a leading French manufacturer at Rheims, has recently stated that the results of investigations in France show that during this century the progress of wages and machinery has been similar—the wages in French wool-manufactories, which were 1½ franc per day in 1816, being (in 1883) 5 francs; while the cost of weaving a meter of merino cloth, which was then 16 francs, is now 1*f.* 45c. "In Nottingham," says Mr. Edwin Chadwick, the distinguished English economist,† "the introduction of more complex and more costly machinery for the manufacture of lace, while economizing labor, augmented wages to the extent of over 100 per cent. I asked a manufacturer of lace whether the large machine could not be worked at the common lower wages by any of the workers of the old machine. 'Yes, it might,' was the answer, 'but the capital invested in the new machinery is very large, and if from drunkenness or misconduct anything happened to the machine, the consequences would be very serious.' Instead of taking a man out of the streets, as might

* "Report on the Statistics of Wages," by Joseph D. Weeks, "Tenth Census of the United States," vol. xx.

† "Employers' Liability for Accidents to Work-people," by Edwin Chadwick.

be done with the low-priced machine, he (the employer) found it necessary to go abroad and look for one of better condition, and for such a one high wages must be given."

A remarkable exhibit made in the annual reports of the Illinois Central Railroad, showing the cost of the locomotive service for each year for the past thirty years, is also especially worthy of attention in connection with this subject. From this it appears that the cost per mile run has fallen from 26·52 cents in 1857 to 13·93 cents in 1886; a reduction which has been effected wholly by inventions and improvements in machinery. But a further point of greater interest is, that during this same period the wages of the engineers and firemen have risen from 4·51 cents to 5·52 cents per mile run; or, in other words, the engineers and firemen on the Illinois Central, who in 1857 received 17 per cent of the entire cost of its locomotive service, received in 1886 nearly 40 per cent (39·6) of the total cost.

The introduction of machinery in many branches of industry—and more especially in agriculture—while increasing, perhaps, the monotony of employment, has also greatly lightened the severity of toil, and in not a few instances has done away with certain forms of labor which were unquestionably brutalizing and degrading, or physically injurious.*

Another paradox which should not be overlooked in this discussion is, that those countries in which labor-saving machinery has been most extensively adopted, and where it might naturally be inferred that population through the displacement and economizing of labor would diminish, or at least not increase, are the very ones in which population has at the same time increased most rapidly.

Taking all the machinery-using countries into account, the number of persons who have been displaced during recent years by new and more effective methods of production and distribution, and have thereby been deprived of occupation and have suffered, does not appear to have been so great as is popularly supposed; a conclusion that finds support in the fact that, notwithstanding trade generally throughout the world has been notably depressed since 1873, through a continued decline in prices, reduction of profits, and depreciation of property, the volume of trade—or the number of things produced, moved, sold, and consumed—on which the majority of those who are the recipients of wages and salaries depend for occupation, has all this time continually increased, and in the aggregate has probably been little if any less than it would have been if the times had been

* Mowing, reaping, raking machinery, winnowing, shelling, and weighing machines, hay-tedders, horse-forks, wheel-harrows, improved plows, better cultivators, and so on through almost the entire list of farm-tools, have combined to make the change in farm-work almost a revolution; and those only who have spent years in farming by old methods can fully realize the extent to which the severity of toil has been lightened to the farmer by the introduction and use of machinery.

considered prosperous. In the United States there is little evidence thus far that labor has been disturbed or depressed to any great extent from this cause. But there is undoubtedly a feeling of apprehension among the masses that the opportunities for employment through various causes—continued large immigration, absorption of the public lands, as well as machinery improvements—are less favorable than formerly, and tend to be still further restricted; and this apprehension finds expression in opposition to Chinese immigration, to the importation of foreign labor on contract, to the increase in the number of apprentices, and in the endeavor to restrict the participation in various employments to membership of certain societies. The reports from many of the large industrial centers of the United States during the past year (1887) have been to the effect, that while specific results are now attained at much less cost and with the employment of much less labor, the increased demand, owing to a reduction in the price and improvement in the quality of the articles manufactured under the new conditions, has operated not merely to prevent any material reduction in the rates of wages, or in the number of employés, but to largely increase both rates and numbers. The annual investigation made by the managers of "Bradstreet's Journal" into the condition of the industries of the country for 1887, indicated that in March of that year 400,000 more industrial employés were at work than in 1885. In thirty-three cities the number of employés at work was 992,000 by the census of 1880, 1,146,000 in January, 1885, and 1,450,000 in March, 1887. The change in the average wages received between 1885–'87 as compared with 1882–'85, shows a very general increase: from 10 to 15 per cent in woolen goods and clothing; 15 in cotton goods, silk goods, and iron-mills; 12 per cent in the wages of three fourths of the employés of beef- and pork-packing establishments; 20 per cent in anthracite-coal mining, and the like. In the case of the boot and shoe industry, an opinion expressed by those competent to judge is, that while "there has been a reduction in cost and in the number of employés per 100 cases produced of from 15 to 20 per cent, the actual number of persons employed has been increased; and in cases where the wages of old classes of workmen are affected they have been raised."

On the Continent of Europe, the grievances of labor attributable to new conditions of production and distribution seem to be mainly confined to the agriculturists and to those bred to handicraft employments; and for both of these classes the outlook is not promising.

In Great Britain the number of persons who are in want, for lack of employment, appears to have largely increased in recent years.*

* "The one thing which I, and those associated with me, always at once peremptorily refuse to do," said recently an English (London) clergyman whose life is among the poor, "is to try and get men, women, and children work to do. I say at once: 'That is impossible. To get you work would be to deprive some other one of work, and that I can not

But as there has been no cessation in the growth of the mechanical industries of the United Kingdom, or in her transportation service by land or sea, or in her production of coal and iron, or in the consumption of her staple food commodities—such growth, although not increasing as it were by "leaps and bounds," as in some former periods (as during the decade from 1865 to 1875), being always in a greater ratio than her increase in population *—it would seem that any increase in the number of her necessarily unemployed must have been mainly derived from the one branch of her industry that has not been prosperous, namely, agriculture, in which the losses in recent years on the part alike of landlords, tenants, and farm-laborers, from decline in land and rental values, in the prices of farm products, and through reduction of wages, has been very great.† Mr. Alfred Russel Wallace inclines to the opinion that twenty thousand English farm-laborers, involving, with their families, a population of from sixty to eighty thousand, were, between 1873 and 1887, obliged to quit their homes, and mostly drifted to the larger cities, in consequence merely of substituting, through the increasing unprofitableness of grain-culture, pasture for arable land; and this substitution is reported as at present continuing at the rate of two hundred and sixty thousand acres per annum.

We have in these facts, furthermore, a clew to the cause of the increased discontent in recent years in Ireland. If the Irish tenantry could pay the rent demanded by the landlords, and at the same time achieve for themselves a comfortable subsistence, there would be no necessity for extraordinary governmental interference on their behalf; and this was what, prior to the years 1873–'75, the prices of farm products—especially of all dairy products—enabled the better class

do,'" the meaning of which was that every occupation in London, in the opinion of the speaker, was full.

* The ratio of increase in the population of the United Kingdom between 1875 and 1885 was about 10 per cent. During the same period the increase in the production of coal was 20 per cent; in pig-iron, 16 per cent; in railway receipts from goods-traffic per head of population, 18 per cent; in shipping engaged in foreign trade, 33 per cent; in consumption of tea per head, 13½ per cent; in sugar per head, 19 per cent.

† "The agricultural returns for Great Britain tell us that, from 1873 to 1884, the quantity of arable land in the country has decreased considerably more than a million acres. The reason of this is chiefly that landlords having farms thrown on their hands, and being unable to obtain fresh tenants, find it the most economical method to lay down the land in permanent pasture, which requires the minimum of labor, superintendence, and expenditure to work. This in part explains the forced exodus of the agricultural laborers no longer required to cultivate the land thus laid down. About twenty-five laborers are required on an arable farm of one thousand acres, while probably five would be ample on the same quantity of pasture; and we should have a diminution of twenty thousand laborers from the change of cultivation which has taken place, or, with their families, a population of sixty or eighty thousand, which, from this cause alone, have been obliged to quit their homes, and have mostly drifted hopelessly to the great towns." In addition, a large number of farms "are now, and have been for some years, lying absolutely waste and uncultivated."—*Bad Times*, Alfred Russel Wallace, London, 1885.

of Irish tenants to achieve. But since then, the fall of prices has entirely changed the condition of affairs and made a reduction and perhaps an entire abolition of the rents of arable land in Ireland an essential, if the Irish tenant is to receive anything in return for his labor. A French economist—M. de Grancey—who has recently published the results of a study of Ireland, founded on a personal investigation of the country, is of the opinion that, although the population of the island has been reduced by emigration from 8,025,000 in 1847 to 4,852,000 in 1887, it is not now capable of supporting in decency and comfort more than from two to three million inhabitants. The same authority tells us that agricultural distress, occasioned by the same agencies, exists to-day in France, in as great a degree as in Great Britain. The peasant proprietors have ceased to buy land and are anxious to sell it; and in the department of Aisne, one of the richest in France, one tenth of the land is abandoned, because it is found that, at present prices, the sale of produce does not cover the expenses of cultivation.*

Now, if it were desirable to search out and determine the primary responsibility for the recent large increase in the number of the English unemployed, or for the distress and revolt of the Irish tenantry, or the growing impoverishment of the French and German peasant proprietors, it would be found that it was not so much the land and rent policy of these different countries that should be called to account, as the farmers on the cheap and fertile lands of the American Northwest, the inventors of their cost-reducing agricultural machinery, of the steel rail, and of the compound marine engine, which, collectively, have made it both possible and profitable "to send the produce of five acres of wheat from Chicago to Liverpool for less than the cost of manuring one acre in England." And, looking into this matter from a cosmopolitan point of view, and balancing the aggregate of good and bad results, how small are the evils which have been entailed upon the agricultural laborers in England, Ireland, or elsewhere, in consequence of changes in the condition of their labor, in comparison with the almost incalculable benefits that have come, in recent years, to the masses of all civilized countries, through the increased abundance and cheapness of food, and a consequent increase in their comfort and vitality!

Another matter vital to this discussion may here and next be properly taken into consideration. As the evidence is conclusive that the direct effect of material progress is to greatly increase and cheapen production and to economize labor; and as there is no reason to sup-

* M. de Grancey is of the opinion that one of the most fertile sources of Irish misery and degradation is the unauthorized and illegal subletting of farms. He states that he met with cases where from forty-five to fifty persons lived in a state of semi-starvation on a farm calculated to yield a comfortable subsistence to a family of five or six. In each generation, the farm, in despite of special prohibitory clauses in the lease, is divided among the sons. Where there are no sons, subtenants are found willing to take small parcels of land at the most exorbitant prices.

pose that the maximum of progress in this direction has been attained, and every reason to expect that the future will be characterized by like and even greater results progressively occurring, the question arises, Is labor to be continually, and in a degree ultimately displaced from occupation by progressive economy of production? Is continual and fiercer competition to effect sales, both of product and labor, in excess of current demands, likely to produce continued disturbance and an unhealthy fall of prices, extensive reductions in wages, and the more extensive employment of the cheaper labor of women and children? Is society working through all this movement toward what has been called an "anarchy of production"?

Experience thus far, under what may be termed the new *régime* of production and distribution, does not, however, fairly warrant any such anticipations. Wages, speaking generally, have not fallen, but have increased; and, except in Germany, there is little indication of a tendency to increase the hours of labor, or encroach upon the reservation of Sunday. Everywhere else, even in Russia, the tendency is in the opposite direction.

Again, the extent and rapidity of the increase in the consumption of all useful and desirable commodities and services which follows every increase in the ability of the masses to consume, is one of the most wonderful of modern economic phenomena; and the one thing which, more than any other, augments their *ability* to consume, is the reduction in the price of commodities, or rather the reduction in the amount of human effort or toil requisite to obtain them, which the recent improvements in the work of production and distribution have effected. Better living, contingent on a reduction of effort necessary to insure a comfortable subsistence, induces familiarity with better things; constitutes the surest foundation for the elevation of the standard of popular intelligence and culture, and creates an increasing desire for not only more but for a higher grade of commodities and services. There are, therefore, two lines upon which the consumption of the products of labor is advancing: the one, in which this stimulant is animal in its nature, and demands food, clothing, shelter, and fuel, for its satisfaction; and the other intellectual, which will only be satisfied by an increased supply of those things which will minister to a higher standard of comfort and education. Thus far the world's manual laborers have not kept up in culture with the improved and quickened methods of production; and therefore in certain departments there is not yet that opportunity for work that there undoubtedly will be in the future.

"There is no good reason why a workingman earning one thousand or fifteen hundred dollars a year, as many do, should not desire as many comforts in the shape of furniture, books, clothing, pictures, and the like for himself and his family, and desire them as intelligently, as the minister, or lawyer, or doctor who is earning a similar amount."

But as abstract conclusions in economic as well as in all other discussions are best substantiated and comprehended through practical examples, to examples let us turn. And first as to certain notable instances derived from recent experiences, showing how remarkably and rapidly increase of consumption has followed reduction of prices, even in cases where the reduction has been comparatively slight, and a marked increase of consumption could not have been reasonably anticipated.

Among the staple food articles that have greatly declined in price during recent years is sugar, and this decline has been attended with a large increase in consumption; the decline in the average price of fair refining sugar in the United States (in bond) having been from 4·75 cents per pound in 1882 to 2·92 cents in 1886; while the average consumption per capita, which was 39 pounds for the five years from 1877 to 1882, was 49·8 pounds for the five years from 1882 to 1887. Comparing 1885 with 1887, the consumption of sugar in the United States increased over 11 per cent, or largely in excess of any concurrent growth of population. Converting, now, so much of this larger consumption as was due to diminished price (probably more than one hundred million pounds) into terms of acres and labor employed in its production; into the ships and men required for its transportation; into the products, agricultural and manufactured, and the labor they represent, that were given in exchange for it, and we can form some idea of the greater opportunities for labor through larger volume of exchanges, and the increased comfort for those who labor, that follows every reduction in the cost necessary to procure desirable things.

In 1887, with an import price of about 16 cents per pound, the importation of coffee into the United States was 331,000,000 pounds. In 1885, with an average import price of eight cents, the importation was 572,000,000 pounds. Between 1873 and 1885 the coffee product of the world that went to market, concurrently with this large decline in its price, increased to the extent of 52 per cent.

The great reduction in recent years in the price of copper, consequent upon its increased product and a surplus offering upon the world's markets, led to such an extraordinary increase in the demand for manufactures of copper and brass, and such a general extension of the uses of the metal, as to finally not only absorb any surplus stock, but also to create apprehension of an inadequacy of supply. For the year 1886 the authorities of the United States Geological Survey estimate that the increase in the consumption of copper by the leading American manufactories of copper and brass was in excess of 24 per cent; and that a very nearly equal increase was experienced in the preceding year (1885); all of which indicates a large if not a fully proportional increase for the periods mentioned in the opportunity for labor, at comparatively high wages, in these departments of industry. On the other hand, with a large advance in the price of copper during the latter

months of 1887, the operations of the manufacturers of copper and brass were reported as having been materially restricted.

Every reduction in the price of gas has been attended with greatly increased consumption, entailing greater demand for labor in the mining and transporting of coal and other materials, and in service of distribution; and it is very doubtful whether the apprehensions of impairment of the value of the capital of the gas companies, which are always excited by such reductions, are ever, to any disastrous extent, realized; and it is the general experience that the profits on the increased demand created by cheaper supply continue to afford to the gas companies reasonable and often equal returns on their invested capital. It seems to be also well established that the extensive introduction and use of the electric light has in no way impaired the aggregate consumption of gas.

In 1830 the average price of cotton cloth in the United States was about seventeen cents per yard; in 1880 it was seven cents. This reduction of price has been accompanied by an increase in the annual per capita consumption of the people from 5·90 pounds of cloth to 13·91 pounds; which in turn represents a great increase in all the occupations connected with cotton, from its growth to its transformation into cloth and cloth fabrications; and the evidence is conclusive that in all these occupations the share of labor in the progressing augmentations of values and quantities has continually increased; the advance in the wages of the cotton-mill operatives, during the period under consideration, having been fully 80 per cent.

When, through competition, the companies controlling the submarine telegraph lines between the United States and Europe reduced in 1886 their rates from 40 to 12 cents per word, 212 words, it was reported, were regularly transmitted in place of every 100 previously sent. Assuming this report to be correct, a comparison of receipts under the new and old rates would give the following results: 210 words at 12 cents each, $25.20; 100 words at 40 cents each, $40; or a reduction in rates of 70 per cent impaired the revenues of the lines to an extent of only 37 per cent.

A reduction in 1886 in the postal system of the United States of *three* cents in the fee for domestic money-orders not exceeding $5 (or from eight to five cents) has operated to increase the use of this service to the remitters of small sums in a very noticeable degree, the average amount of each order issued in 1887 being but $12.72 as against an average of $14.33 in 1886, and larger sums in previous years; while the increase in the number of money-orders issued in 1887 was 16·27 per cent greater than in 1886. The aggregate value of these orders for 1887 is returned at the large sum of $117,462,000.

The following have been the economic changes within a decade in the business of manufacturing American watches, and the manner in which such changes have affected the welfare alike of owners and

employés: "A great reduction in price from which there has been no recovery. Business has invariably, and with scarcely notable friction, adjusted itself to new conditions; and save only in exceptional cases —new companies struggling for a place—the capital invested has been fairly remunerative. Best of all, the wages of operatives have been maintained; for one reason among others, that reductions in rates paid for piece-work have operated to stimulate the intelligence of the workman, so that he devises for his special works methods and appliances which not only increase his speed but his product also, and improve its quality. The great decline in recent years in the price of American watches has not been caused by the importation of foreign watches, but has sprung wholly out of an intense competition between American manufacturers; and from this and other causes the industry has experienced all the vicissitudes incident to the occurrence of what are generally denominated 'hard times.'"

The following examples of the increase in the consumption of commodities, consequent on reductions of price through abatements of taxation, also indicate how largely the opportunities for labor and of the sphere of exchanges or business can be increased in the future by an extension of this policy:

Reductions in the price of tea in Great Britain, following a progressive reduction in the duties on the imports of this commodity, from 2*s.* 2½*d.* in 1852 to 6*d.* (the present rate), have been accompanied by an increase in its annual consumption from 58,000,000 pounds in 1851 to 337,000,000 in 1885, or from 1·9 pound per head of the population to 5 pounds.

A removal in 1883 of the comparatively small tax of one cent on every hundred matches imposed by the United States, is reported to have reduced the price about one half, and to have increased the domestic consumption to the extent of nearly one third.

In 1883 a few additions were made to the free list under the tariff of the United States, and among them were included unground spices, which had been previously subjected to duties, which, although heavy as *ad valorem*, were in themselves so small specifically (as five cents per pound each on pepper, cloves, and pimento) that their influence on the consumption of the American people, with their acknowledged tendency to extravagance, would not have been generally regarded as likely to be considerable; and yet the removal of the duties on these commodities, which pass almost directly into consumption, carried up their importations in the following remarkable manner: In the case of pepper, from 6,973,000 pounds in 1883 to 10,995,000 pounds in 1886; pimento, from 1,283,000 pounds to 2,500,000 pounds; cassia-buds, from 27,739 pounds to 238,000; cloves, from 989,000 pounds to 1,298,000; nutmegs, from 661,132 pounds to 1,189,456; while the importation and consumption of mace in the country more than doubled and that of cayenne pepper more than trebled during the same period. It is evi-

dent, therefore, that the masses of the United States during the continuance of these taxes did not have all the spices they would like, to make their food more palatable and savory; that trade between the spice-producing countries and the United States was restricted; and, as all trade is essentially an exchange of product for product, that the labor of the United States gained under the new conditions, either by sharing in the greater abundance of useful things, or through an increased opportunity for labor in producing the increase of commodities that the increase of exchanges demanded.

The original cost of the suspension-bridge between the cities of New York and Brooklyn was $15,000,000, entailing an annual burden of interest at five per cent of $750,000. When first opened to public use in September, 1883, the rates of fare were fixed at five cents per ticket for the cars, and one cent per ticket for foot-passengers, no ticket being sold at any less price by packages. The total receipts for the first year (1883–'84) from all traffic sources were $402,938, and the total number of car and foot passengers was 11,503,440; 5,324,140 of the former and 6,179,300 of the latter. The results of the first year's operations were not, therefore, encouraging as to the ability of the bridge to earn the interest on the cost of its construction. During the second year (1884–'85), the rates of fare remaining the same, the increase in the aggregate number of passengers was comparatively small, or from 11,503,440 to 14,051,630; but in February, 1885, the rates of fare were greatly reduced—i. e., tickets for the cars (when sold in packages of ten) from five cents to two and a half, and tickets for promenade (when bought in packages of twenty-five) from one cent to one fifth of a cent. The results of this reduction immediately showed themselves in a remarkable increase for the year of 71 per cent in the number of car and foot passengers, or from an aggregate of 14,051,630 in 1884–'85 to 25,082,587 in 1885–'86, and this aggregate has gone on increasing to 30,604,726 for the year ending December 1, 1887. Concurrently also the bridge receipts from traffic have increased from $565,544.45 in 1884–'85 (the last year of high fares) to $850,724 for the year ending November 30, 1887, with a net profit on the operations of the year of $495,319, or nearly enough to pay two thirds of the interest on the original investment; or, the result of the bridge operations since the reductions of the rates for its use has been accompanied by an increased passenger movement—car and foot—of 108 per cent, and a gain in receipts of 50 per cent.

A further analysis of the experiences of the New York and Brooklyn Bridge since its construction also reveals some curious tendencies of the American people in respect to consumption and expenditures. During the first year the bridge was open to the public, the number of foot-passengers paying one cent was 6,179,300, and the number of car-passengers paying five cents was 5,324,140. The next year, fares remaining unchanged, the number of foot-passengers declined to 3,679,-

733, and the number of car-passengers increased to 11,951,630. In the third year, with a reduction of foot-fares to one fifth of a cent, the number of foot-passengers declined 440,395, or to an aggregate of 3,239,337; while the number of car-passengers (with a reduction of fare from five to two and a half cents) increased 10,130,957, or to 21,843,250. For the year ending December 1, 1887, the number of foot-passengers further declined 574,929, or to 2,664,413, while the number of car-passengers further increased 8,097,063, or to 27,940,313; or to a total aggregate of 30,604,313. A correct explanation of these curious results may not be possible, but one inference from them that would seem to be warranted is, that when the American people find their pecuniary ability is abundantly sufficient to enable them to satisfy their desire for certain commodities or services, they will disdain to economize; and this idea may find illustration and confirmation in another incident of recent American experience. Thus, when the great decline in the price of sugars occurred in 1883, the American refiners expected that, whatever of increase of consumption might be attendant, would occur mainly in the lower grades of sugar; but, to their surprise, the actual increase was largely in respect to the higher grades. A leading refiner, who, somewhat puzzled at this result, asked one of his workmen for an explanation of it, received the following answer: "I give my wife fifty cents every Monday morning with which to buy sugar for the week for my family, and, as she finds that fifty cents will now buy as many pounds of the white as we once could get of the yellow sugars, she buys the white." A European workman (certainly a Frenchman) would probably have acted differently. He would have taken the same grade as before and got two pounds of additional sweetening for his money; or, more likely, he would have bought the same quantity and quality as before, and saved up the measure of the decline of price in the form of money.

Another explanation of the bridge phenomenon may be that the average American, who is always in a hurry, may think that, with the privilege of riding for two and a half cents, he can not afford the time to avail himself of the privilege of walking for a payment of one fifth of a cent.

Mr. Robert Giffen, in a review of the "Recent Rate of Material Progress in England" (British Association, 1887), recognizes an evident tendency, as that country increases in wealth, for the numbers employed in miscellaneous industries, and in what may be called "incorporeal functions"—that is, as artists, teachers, and others, who minister to taste and comfort in a way that can hardly be called material—to increase disproportionately to those engaged in the production of the great staples; and that, therefore, the production of these latter is not likely to increase as rapidly as heretofore. All of which is equivalent to affirming that, in virtue of natural law, the evils resulting from the displacement of labor, through more economic methods of

production by machinery, are being gradually and to a large extent counteracted. No one can doubt that this is the tendency in the United States equally as in England, and it finds one striking illustration in the large number of new products that are demanded, and in the number of occupations that have been greatly enlarged or absolutely created in recent years, in consequence of the change in popular taste, conjoined with popular ability, to incur greater expense in the matter of house-building and house-decoration. Ten or fifteen years ago the amount of fine outside work in building constructions—in brick, terra-cotta, stone, and metal—and on interiors, in the way of painting, paper-hangings, wall-coverings with other materials, fine wood-work, carving, furniture-making, carpet-weaving, draperies for doors and windows, stained glass and mirrors, and improved and elaborate sanitary heating and ventilating apparatus, was but a very small fraction of what is now required. Nothing, furthermore, is more certain than that all these departments of industry are to continue progressively enlarging; for all achievements in this direction increase taste and culture, and these in turn create new and enlarged spheres for industrial occupation.

How these same influences exert themselves for the extension of the intercommunication of intelligence, with the attendant increased demand for service and materials which represent opportunities for labor, is exemplified in the following postal statistics, the result of recent German investigation: Thus, for the year 1865 it is estimated that the inhabitants of the world exchanged about 2,300,000,000 letters; in 1873, the aggregate was 3,300,000,000; in 1885, including postal-cards, it was 6,257,000,000; in 1886, 6,926,000,000, with a larger ratio of increase in the transmission of printed matter, patterns, and other articles; the whole business giving employment to about 500,000 persons, for more than one half of which number there was probably no requirement for service under conditions existing in 1873. And to this aggregate should be added the increased number required to meet the greater requirements for the machinery and service of larger transportation, and vastly larger consumption of all the material and service incident to correspondence. The experience of the postal service of the United States also shows that, at all those points where a free delivery of letters has been established, the postal revenues have quickly and greatly augmented—another illustration that every increased and cheapened facility for use or consumption brings with it greater demands for service or production.

In view, then, of the undoubted tendency, as abundance or wealth increases, for labor to transfer itself, in no small proportions, from lower to higher grades—from the production of the great staples to occupations that minister to comfort and culture, rather than to subsistence—how impolitic, from the standpoint of labor's interests, seems to be the imposition of high taxes (as in the United States) on the impor-

tation of works of art of a high character and large cost, under the assumption that it is desirable to tax all such articles as luxuries, and that it is for the interest of the masses to adopt such a policy! In illustration, let us suppose a man of wealth to purchase and import a costly and beautiful art product. Having obtained it, he rarely finds a compensating return for his expenditure in an exclusive and selfish inspection, but rather in exhibiting it to the public; and the public go away from these exhibitions with such higher tastes and culture as impel them to desire to have in their life-surroundings, as much that is artistic and beautiful—not the work of one, but of many—as their means will allow; even if it be no more than a cheerful chromo-lithograph, a photograph, a carpet or a curtain of novel and attractive design, a piece of elegant furniture, or of bronze, porcelain, or pottery. And to supply the new and miscellaneous industries that are created or enlarged by such desires and demands, labor will be, as it were, constantly drained off from occupations in which improved machinery tends to supplant it, into other spheres of employment in which the conditions and environments are every way elevating, because in them the worker is less of a machine, and the rewards of labor are very much greater.

The phenomena of the overproduction of certain staple commodities, although for the time being often a matter of difficulty and the occasion of serious industrial and commercial disturbances, are also certain, in each specific instance, to sooner or later disappear in virtue of the influence of what may be regarded as economic axioms, namely: that we produce to consume, and that, unless there is perfect reciprocity in consumption, production will not long continue in a disproportionate ratio to consumption; and also that, under continued and marked reduction of prices, consumption will quickly tend to increase and equalize, or accommodate itself to production. Illustrations of the *actual* and *possible* under this head, and of the rapidity with which conditions are reversed and "overproduction" disappears, are most curious and instructive. For example, all authorities in 1885 were agreed that the then existing capacity for manufacturing cotton was greatly in excess of the world's capacity for consumption; the season of 1885–'86 closing with a surplus of nearly 400,000,000 yards on the British market, for which the manufacturers found no demand. Since that date, however, and with no special renewal of business activity in any country except the United States, the world's consumption of cotton fabrics has reached a larger total than ever before, and there are probably at the present time (1888) no more spindles in existence than are necessary to supply the current demands for their products. In the case of sugar, also, an increase in consumption occasioned by low prices, and a notable restriction of production through the same price influences, has reduced an estimated actual surplus of sugar on the world's markets in October, 1885, of 1,042,956 tons, to 568,188 tons in October, 1887,

"with a good prospect of all surplus being wiped out by October, 1888." The price of fair refining sugar (in bond, which represents the world's prices) has accordingly advanced from 2·37½ cents per pound in July, 1887, to 3·22 in January, 1888.

The production of very few articles has increased in recent years in a ratio so disproportionate to any increase of the world's population as that of iron, and prices of some standard varieties have touched a lower range than were ever before known. Gloomy apprehensions have accordingly been entertained respecting continued overproduction, and its disastrous influence in the future on the involved capital and labor. To comprehend, however, the possibilities for this industry in the future, it is only necessary to have in mind that in 1882 (and the proportions have not probably since varied) the population of the United States and of Europe (398,333,750), comprising less than one fourth of the total population of the world (1,424,686,000), consumed nineteen twentieths of the whole annual production of iron and steel; and that if the population of the world outside of Europe and the United States should increase its annual per capita consumption of iron (which is not now probably in excess of two pounds) to only one half of the average annual per capita consumption of the people of a country as low down in civilization as Russia, the annual demand upon the existing producing capacity of iron would be at once increased to the extent of over six million tons. And, when it is further remembered that civilization is rapidly advancing in many countries, like India, where the present annual consumption of iron per head is very small (2·4 pounds), and that civilization can not progress to any great extent without the extensive use of iron, the possibilities for the enormous extension of the iron industry in the future, and the enlarged sphere of employment of capital and labor in connection therewith, make themselves evident.*

As constituting a further contribution to the study of the so-called

* According to a table presented to the British Iron Trade Association by Mr. Jeans in 1882, and subsequently incorporated in a report submitted by Sir Lowthian Bell to the British Commission "On the Depression of Trade" in 1885 (and from which the above data have been derived), the total consumption of iron in the above year was 20,567,746 tons. Of this aggregate, the United States and the several countries of Europe, with a population at that time of 398,333,750, consumed 19,057,963 tons; the following five countries, namely, the United States, the United Kingdom of Great Britain, France, Germany, and Belgium, with a population of 174,506,935, consuming 16,259,514 tons. The aggregate consumption of iron by the population of all the other countries of the world at that time (assumed to be 1,026,538,820) was estimated at 1,509,783 tons, or, deducting the consumption of the population of the British possessions other than in India (as Australia, etc.), at only 888,298 tons, or 1·96 pound per head per annum. The annual per capita consumption of different countries in 1882 was reported as follows: The United Kingdom, 287 pounds; the United States, 270 pounds; Belgium, 238 pounds; France, 149 pounds; Germany, 123 pounds; Sweden and Norway, 77 pounds; Austrian territories, 37 pounds; Russia, 24·6 pounds; South America and the islands, 13·5 pounds; Egypt, 7·5 pounds; India, 2·4 pounds.

industrial phenomenon of "overproduction," and as illustrating how a greater abundance and cheaper price of desirable commodities, work for the equalization and betterment of the conditions of life among the masses, the recent experience of the article quinine should not be overlooked. Owing to greatly increased and cheaper supplies of the cinchona-bark, from which quinine is extracted, and to the employment of new and more economical processes, by which more quinine can be made in from three to five days than could be in twenty under the old system, the markets of the world in recent years have been overwhelmed with supplies of this article, and its price has declined in a most rapid and extraordinary manner, namely: from 16*s.* 6*d.* ($4.70) the ounce in the English market in 1877, to 12*s.* ($3) in 1880; 3*s.* 6*d.* (80 cents) in 1883; 2*s.* 6*d.*, in 1885; and to 1*s.* 6*d.* (30 cents), or less, in 1887. As quinine is a medicine, and as the increase in the consumption of medicines is dependent upon the real or fancied increase of ill-health among the masses, rather than on any reduced cost of supply (although, in the case of this specific article, decreased cost has undoubtedly somewhat increased its legitimate consumption), the problem of determining how a present and apparently future overproduction was to be remedied has been somewhat difficult of solution. But recently the large manufacturers in Europe have made an arrangement to put up quinine (pills) protected by gelatine, and introduce and offer it so cheaply in the East Indies and other tropical countries, as to induce its extensive consumption on the part of a vast population inhabiting malarious districts which has hitherto been deprived of the use of this valuable specific by reason of its costliness. And it is anticipated that by reason of its cheapness it may, to a considerable extent, supersede the use of opium among the poorer classes living along the Chinese rivers, who it is believed extensively consume this latter pernicious and costly drug, not so much for its mere narcotic or sensual properties, as for the relief it affords to the fever depression occasioned by malaria.

All this evidence, therefore, seems to lead to the conclusion that there is little foundation for the belief largely entertained by the masses, and which has been inculcated by many sincere and humane persons who have undertaken to counsel and direct them, that the amount of remunerative work to be done in the world is a fixed quantity; and that the fewer there are to do it the more each one will get. When the real truth is, that work as it were breeds work; that the amount to be done is not limited; that the more there is done the more there will be to do; and that the continued increasing material abundance which follows all new methods for effecting greater production and distribution, is the true and permanent foundation, and the certain assurance of continually increasing prosperity for the masses in the future.

NEW CHAPTERS IN THE WARFARE OF SCIENCE.

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IV.—GEOLOGY (*concluded*).

LONG before the end of the struggle described in the last article, even at a very early period, the futility of the usual scholastic weapons had been seen by the more keen-sighted champions of orthodoxy; and, as the difficulties of the ordinary attack upon science became more and more evident, many of these champions began endeavors to patch up a truce. So began the third stage in the war—the period of attempts at compromise.

The position which the compromise party took was that the fossils were produced by the Deluge of Noah.

This position was strong, for it was apparently based upon Scripture. Moreover, it had high ecclesiastical sanction—some of the fathers had held that fossil remains, even on the highest mountains, represented animals destroyed at the Deluge—Tertullian was especially firm on this point, and St. Augustine thought that a fossil tooth discovered in North Africa must have belonged to one of the giants mentioned in Scripture.*

In the sixteenth century especially, weight began to be attached to this idea by those who felt the worthlessness of various scholastic explanations. Strong men in both the Catholic and the Protestant camps accepted it; but the man who did most to give it an impulse into modern theology was Martin Luther. With his keen eye he saw that scholastic phrase-making could not meet the difficulties raised by fossils, and he naturally urged the doctrine of their origin at the Deluge of Noah.†

With such support, it soon became the dominant theory in Christendom. Nothing seemed able to stand against it, but before the end of the same sixteenth century it met some serious obstacles. Bernard Palissy, one of the most keen-sighted of scientific thinkers in France, as well as one of the most devoted of Christians, showed that this theory was utterly untenable. Conscientious investigators in other parts of Europe, and especially in Italy, showed the same thing.‡ All in vain—in vain did good men protest against the injury sure to be brought upon religion by tying it to a scientific theory sure to be ex-

* For Tertullian, see his "De Pallio," c. ii (Migne, "Patr. Lat.," ii, 1033). For Augustine's view, see Cuvier, "Recherches sur les Ossements fossiles," fourth edition, vol. ii, p. 143.

† For Luther's opinion, see his "Commentary on Genesis."

‡ For a very full statement of the honorable record of Italy in this respect, and for the enlightened views of some Italian churchmen, see Stoppani, "Il Dogma e le Scienze Positive," Milan, 1886, pp. 203 *et seq.*

ploded; the doctrine that fossils were the remains of animals drowned at the Flood continued to be upheld by the great majority of theological leaders for nearly three centuries as "sound doctrine," and as a blessed means of reconciling science with Scripture.* To sustain this scriptural view, efforts were put forth absolutely Herculean both by Catholics and Protestants.

In Germany, early in the seventeenth century (1612), Dr. Wolfgang Franz, Professor of Theology at Wittenberg, published his "Sacred History of Animals," described dragons with three ranges of teeth, and calmly added, "The greatest of these is the devil." This book was influential upon thought for a hundred years. It claimed to be designed for "students of theology and ministers of the word," and especially to instruct clergymen how, in biblical fashion, to utilize the various traits of animals to the edification of their hearers.†

In France the learned Benedictine, Calmet, in his great works on the Bible, accepted this view as late as the beginning of the eighteenth century, believing the mastodon's bones exhibited by Mazurier to be those of King Teutobocus, and held them valuable testimony to the existence of the giants mentioned in Scripture and of the early inhabitants of the earth overwhelmed by the Flood.‡

But the greatest champion appeared in England. We have already seen how, near the close of the seventeenth century, Thomas Burnet prepared the way in his "Sacred Theory of the Earth" by rejecting the discoveries of Newton, and showing how sin led to the breaking up of the "foundations of the great deep"; and we have also seen how Whiston, in his "New Theory of the Earth," while yielding a little and accepting the discoveries of Newton, brought in a comet to aid in producing the Deluge; but far more important than these in his permanent influence was John Woodward, professor at Gresham College, a leader in scientific thought at the University of Cambridge, and, as a patient collector of fossils and an earnest investigator of their meaning, deserving of the highest respect. In 1695 he published his "Natural History of the Earth," and rendered one great service to science, for he yielded another point, and thus destroyed the foundations for the old theory of fossils. He showed that they were not "sports of Nature," or "models inserted by the Creator in the strata for some inscrutable purpose," but that they were really remains of living beings. So far, he rendered a great service both to science and religion; but, this done, the text of the Old Testament narrative and the famous passage in St. Peter's Epistle were too strong for him,

* See Audiat, "Vie de Palissy," p. 412, and Cantu, "Hist. universelle," vol. xv, p. 492.

† See Franz, "Historia Animalium," edition of 1671, especially in the preface; also Perrier, "La Philosophie zoologique avant Darwin," Paris, 1884, p. 29.

‡ See Calmet, "Dissertation sur les Géants," cited in Berger de Xivrey, "Traditions tératologiques," p. 191.

and he, too, insisted that the fossils were produced by the Deluge. Strengthened by his great authority, the assault on the true scientific position was strong: Mazurier exhibited certain fossil remains of a mammoth discovered in France as bones of the giants mentioned in Scripture; Father Torrubia did the same thing in Spain; Increase Mather sent to England similar remains discovered in America, with a like statement.

For the edification of the faithful, such "bones of the giants mentioned in Scripture" were hung up in public places. Jurieu saw some of them thus suspended in one of the churches of Valence; and Henrion, apparently under the stimulus thus given, drew up tables showing the size of our antediluvian ancestors, in which the height of Adam was given as 123 feet 9 inches, that of Eve as 118 feet 9 inches and 9 lines.*

But the most brilliant service rendered to the theological theory came from another quarter; for, in 1726, Scheuchzer, having discovered a large fossil lizard, exhibited it to the world as the "human witness of the Deluge";† this great discovery was hailed everywhere with joy, for it seemed to prove not only that human beings were drowned at the Deluge, but that "there were giants in those days." Cheered by the applause thus gained, he determined to make the theological position impregnable. Mixing together various texts of Scripture with notions derived from the philosophy of Descartes and the speculations of Whiston, he developed the theory that "the fountains of the great deep" were broken up by the direct physical action of the hand of God, which, literally applied to the axis of the earth, suddenly stopped the earth's rotation, broke up "the fountains of the great deep," spilled the water therein contained, and produced the Deluge. But his service to sacred science did not end here, for he prepared an edition of the Bible, in which magnificent engravings in great number illustrated his view and enforced it upon all readers. Of these engravings no less than thirty-four were devoted to the Deluge alone.‡

In the midst of this war appeared an episode very comical but very

* See Cuvier, "Recherches sur les Ossements fossiles," fourth edition, vol. vii, p. 56; also, Geoffroy St.-Hilaire, cited by Berger de Xivrey, "Traditions tératologiques," p. 190.

† "Homo diluvii testis."

‡ See Zöckler, vol. ii, p. 172. For the ancient belief regarding giants, see Leopardi, "Saggio." For accounts of the views of Mazurier and Scheuchzer, see Cuvier; also, Büchner, "Man in Past, Present, and Future," English translation, pp. 235, 236. For Increase Mather's views, see "Philosophical Transactions," vol. xxiv, p. 85. As to similar fossils sent from New York to the Royal Society as remains of giants, see Weld, "History of the Royal Society," vol. i, p. 421. For Father Torrubia and his "Gigantologia Española," see D'Archiac, "Introduction à l'Étude de la Paléontologie stratographique," Paris, 1864, p. 201. For admirable summaries, see Lyell, "Principles of Geology," London, 1867; D'Archiac, "Géologie et Paléontologie," Paris, 1866; Pictet, "Traité de Paléontologie," Paris, 1853; Vezian, "Prodrome de la Géologie," Paris, 1863; Haeckel, "History of Creation," English translation, New York, 1876, chapter iii; and,

instructive; for it shows that the attempt to shape the deductions of science to meet the exigencies of theology may mislead heterodoxy as absurdly as orthodoxy.

About the year 1760 news of the discovery of marine fossils in various elevated districts of Europe reached Voltaire. He, too, had a theologic system to support, though his system was opposed to that of the sacred books of the Hebrews. He feared that these new discoveries might be used to support the Mosaic accounts of the Deluge: all his wisdom and wit, therefore, were compacted into arguments to prove that the fossil fishes were remains of fishes intended for food, but spoiled and thrown away by travelers; that the fossil shells were accidentally dropped by Crusaders and Pilgrims returning from the Holy Land; and that sundry fossil bones found between Paris and Étampes were parts of a skeleton belonging to the cabinet of some ancient philosopher. Through chapter after chapter, Voltaire, obeying the supposed necessities of his theology, fought desperately the growing results of the geologic investigations of his time.*

But far more prejudicial to Christianity was the continued effort on the other side to show that the fossils were caused by the Deluge of Noah.

No supposition was too violent to support this theory, which was considered vital to the Bible. By taking the mere husks and rinds of biblical truth for truth itself, by taking sacred poetry as prose, and by giving a literal interpretation of it, the followers of Burnet, Whiston, and Woodward built up systems which bear to real geology much the same relation that the "Christian Topography" of Cosmas bears to real geography. In vain were exhibited the absolute geological, zoölogical, astronomical proofs that no universal deluge, or deluge covering any great extent of the earth, had taken place within the last six thousand or sixty thousand years; in vain did so enlightened a churchman as Bishop Clayton declare that the Deluge could not have taken place save in that district where Noah lived before the Flood; in vain did others, like Bishop Croft and Bishop Stillingfleet, and the nonconformist Matthew Poole, show that the Deluge might not have been and probably was not universal; in vain was it shown that, even if there had been a universal deluge, the fossils were not produced by it: the only answers were the citation of the text, "And all the high mountains which were under the whole heaven were covered," and, to clinch the matter, Worthington and men like him insisted that any argument to show that fossils were not remains of animals drowned at the Deluge of Noah was "infidelity." In England, France, and

for the most recent progress, Professor O. S. Marsh's "Address on the History and Methods of Paleontology," given at Saratoga in 1879.

* See Voltaire, "Dissertation sur les Changements arrivés dans notre Globe"; also, Voltaire, "Les Singularités de la Nature," chapter xii; also, Jevons, "Principles of Science," vol. ii, p. 328.

Germany, belief that the fossils were produced by the Deluge of Noah was insisted upon as part of that faith essential to salvation.*

But the steady work of science went on; not all the force of the Church—not even the splendid engravings in Scheuchzer's Bible—could stop it; and the foundations of this theological theory began to crumble away. The process was, indeed, slow; it required a hundred and twenty years for the searchers of God's truth, as revealed in Nature—such men as Hooke, Linnæus, Whitehurst, Daubenton, and Cuvier—to push their works under this fabric of error, and, by statements which could not be resisted, to undermine it. As we arrive at the beginning of the nineteenth century, science is becoming irresistible in this field. Blumenbach, Von Buch, and Schlotheim lead the way, but most important is the work of Cuvier. In the early years of the present century, his researches among fossils began to throw new light into the whole subject of geology: he was, indeed, very wary and diplomatic, and seemed, like Voltaire, to feel that "among the wolves one must howl a little." It was a time of reaction. Napoleon had made peace with the Church, and to disturb that peace was akin to treason. Still, by large but vague concessions, Cuvier kept the theologians satisfied, while he undermined their strongest fortress. The danger was instinctively felt by some of the champions of the Church, and typical among these was Chateaubriand; and in his best-known work, once so great, now so little—the "Genius of Christianity"—he grappled with the questions of creation by insisting upon a sort of general deception "in the beginning," under which everything was created by a sudden fiat, but with appearances of pre-existence. His words are as follows: "It was part of the perfection and harmony of the nature which was displayed before men's eyes that the deserted nests of last year's birds should be seen on the trees, and that the sea-shore should be covered with shells which had been the abode of fish, and yet the world was quite new, and nests and shells had never been inhabited."† But the real victory was with Brongniart, who, about 1820, gave forth his work on fossil plants, and thus built a barrier against which the enemies of science raged in vain.‡

Still the struggle was not ended, and, a few years later, a forlorn hope was led in England by Granville Penn.

His fundamental thesis was that "our globe has undergone only two revolutions, the Creation and the Deluge, and both by the immediate fiat of the Almighty"; he insisted that the Creation took place

* For a candid summary of the proofs from geology, astronomy, and zoölogy, that the Noachian Deluge was not universally or widely extended, see McClintock and Strong, "Cyclopædia of Biblical Theology and Ecclesiastical Literature," article "Deluge." For general history, see Lyell, D'Archiac, and Verian. For special cases showing the bitterness of the conflict, see the Rev. Mr. Davis's "Life of Rev. Dr. Pye Smith," *passim*.

† "Génie du Christianisme," chapter v, pp. 1–14, cited by Reusch, vol. i, p. 250.

‡ For admirable sketches of Brongniart and other paleobotanists, see Ward, as above.

in exactly six days of ordinary time, each made up of "the evening and the morning"; and he ended with a piece of that peculiar presumption so familiar to the world, by calling on Cuvier and all other geologists to "ask for the old paths and walk therein until they shall simplify their system and reduce their numerous revolutions to the two events or epochs only—the six days of Creation and the Deluge."* The geologists showed no disposition to yield to this peremptory summons; on the contrary, the President of the British Geological Society, and even so eminent a churchman and geologist as Dean Buckland, soon acknowledged that facts obliged them to give up the theory that the fossils of the coal-measures were deposited at the Deluge of Noah, and to deny that the Deluge was universal. The combat deepened; churchmen and dissenters were alike aroused; from pulpit and press missiles were showered upon men of science. As typical we may take Fairholme, who in 1837 published his "Mosaic Deluge" and argued that no early convulsions of the earth, such as those supposed by geologists, could have taken place, because there could have been no deluge "before moral guilt could possibly have been incurred"—that is to say, before the creation of mankind. In touching terms he bewailed the defection of the President of the Geological Society and Dean Buckland—protesting against geologists who "persist in closing their eyes upon the solemn declarations of the Almighty."†

Still the geologists continued to seek truth, and those theologians who felt that denunciation of science as "godless" could accomplish little labored upon schemes for reconciling geology with Genesis. Some of these show amazing ingenuity, but an eminent religious authority, going over them with great thoroughness, has well characterized them as "daring and fanciful."‡ Such attempts have been variously classified; but the fact regarding them all is that each mixes up more or less of science with more or less of Scripture, and produces a result more or less absurd. Though a few men here and there have continued these exercises, the capitulation of the party which set the literal account of the Deluge of Noah against the facts revealed by geology was at last clearly made.

One of the first evidences of the completeness of this surrender has been so well related by the eminent physiologist, Dr. W. B. Carpenter, that it may best be given in his own words: "You are familiar with a book of considerable value, Dr. W. Smith's 'Dictionary of the Bible.' I happened to know the influences under which that dictionary was framed. The idea of the publisher and of the editor was to give as much scholarship and such results of modern criticism as should be compatible with a very judicious conservatism. There was to be no objection to geology, but the universality of the Deluge was to be

* See the works of Granville Penn, vol. ii, p. 273.

† See Fairholme, "Mosaic Deluge," London, 1837, p. 358.

‡ See Shields, "The Final Philosophy," p. 340.

strictly maintained. The editor committed the article 'Deluge' to a man of very considerable ability, but, when the article came to him, he found that it was so excessively heretical that he could not venture to put it in. There was not time for a second article under that head, and, if you look in that dictionary, you will find under the word 'Deluge' a reference to 'Flood.' Before 'Flood' came, a second article had been commissioned from a source that was believed safely conservative. But, when the article came in, it was found to be worse than the first. A third article was then commissioned, and care was taken to secure its 'safety.' If you look for the word 'Flood' in the dictionary, you will find a reference to 'Noah.' Under that name you will find an article written by a distinguished professor of Cambridge, of which I remember that Bishop Colenso said to me at the time, 'In a very guarded way the writer concedes the whole thing.' You will see by this under what trammels scientific thought has labored in this department of inquiry."*

A similar surrender was seen when from a new edition of Bishop Horne's "Introduction to the Scriptures," the standard text-book of orthodoxy, its accustomed use of fossils to prove the universality of the Deluge was quietly dropped.†

The date of a similar capitulation in the United States was fixed, when somewhat later two divines, among the most eminent for piety and scholarship, inserted in the "Biblical Cyclopædia" published under their supervision, a candid summary of the proofs from geology, astronomy, and zoölogy that the Deluge of Noah was not universal, or even widely extended, and this without protest from any man of note in any branch of the American Church.‡

The time when the struggle was relinquished by enlightened theologians of the Roman Catholic Church may be fixed at about 1862, when Reusch, professor of theology at Bonn, in his work on "The Bible and Nature," cast off the old diluvial theory and all its supporters, accepting the conclusions of science.*

But, though the sacred theory with the Deluge of Noah as a universal solvent for geological difficulties was dead, there still remained in various quarters a touching fidelity to its memory. In Roman Catholic countries the old theory has been widely though quietly cherished and taught from the religious press, the pulpit, and the theological professor's chair: Pope Pius IX was doubtless in sympathy with this feeling when, about 1850, he forbade the scientific congress of Italy to meet at Bologna.‖

* See "Official Report of the National Conference of Unitarian and other Christian Churches, held at Saratoga, 1882," p. 97.

† This was about 1856; see Tylor, "Early History of Mankind," p. 328.

‡ McClintock and Strong, "Cyclopædia of Biblical Knowledge," etc., article "Deluge."

* See Reusch, "Bibel und Natur," chap. xxi.

‖ See Whiteside, "Italy in the Nineteenth Century," vol. iii, chap. xiv.

In 1856 Father Debreyne congratulated the theologians of France on their admirable attitude: "instinctively," he says, they still insist upon deriving the fossils from Noah's Flood.* In 1875 the Abbé Choyer published at Paris and Angers a text-book widely approved by church authorities, in which he took similar ground; and in 1877 the Jesuit father, Bosizio, published at Mayence a treatise on geology and the Deluge, endeavoring to hold the world to the old solution of the problem, allowing, indeed, that the "days" of creation were long periods, but making atonement for this concession by sneers at Darwin.†

In the Russo-Greek Church, in 1869, Archbishop Macarius, of Lithuania, urged the necessity of believing that Creation in six days of ordinary time and the Deluge of Noah are the only causes of all that geology seeks to explain; and, as late as 1876, another eminent theologian of the same church went even farther, and refused to allow the faithful to believe that any change had taken place since "the beginning" mentioned in Genesis, when the strata of the earth were laid, tilted, and twisted, and the fossils scattered among them by the hand of the Almighty during six ordinary days.‡

In the Lutheran branch of the Protestant Church we also find some echoes of the old belief. Keil, eminent in scriptural interpretation at the University of Dorpat, gave forth in 1860 a treatise insisting that geology is rendered futile and its explanations vain by two great facts —the Curse which drove Adam and Eve out of Eden, and the Flood that destroyed all living things save Noah, his family, and the animals in the ark. In 1867, Phillippi, and in 1869, Diedrich, both theologians of eminence, took virtually the same ground in Germany, the latter attempting to beat back the scientific hosts with a phrase apparently pithy, but really hollow—the declaration that "modern geology observes what is, but has no right to judge concerning the beginning of things." As late as 1876, Zugler took a similar view, and a multitude of lesser lights, through pulpit and press, brought these anti-scientific doctrines to bear upon the people at large—the only effect being to deaden the intellects of the peasantry in general and to arouse grave doubts regarding Christianity among the more thoughtful young men, who naturally distrusted a cause using such weapons.*

The results of this policy, both in Roman Catholic and in Protestant countries, are not far to seek. What the condition of thought is among the middle classes of France and Italy needs not to be stated here. In Germany, as a typical fact, it may be mentioned that there was in the year 1881 church accommodation in the city of Berlin for

* See Zöckler, vol. ii, p. 472.

† See Zöckler, vol. ii, p. 478, and Bosizio, "Geologie und die Sündfluth," Mayence, 1877, preface, p. xiv.

‡ See Zöckler, vol. ii, pp. 472, 571.

* See citations in Zockler, Reusch, and Shields.

but two per cent of the population, and that even this accommodation was more than was needed. This fact is not due to the want of a deep religious spirit among the North Germans: no one who has lived among them can doubt the existence of such a spirit; but it is due mainly to the fact that, while the simple results of scientific investigation have filtered down among the people at large, the dominant party in the Lutheran Church has steadily refused to recognize this fact, and has persisted in imposing on Scripture the fetters of literal and dogmatic interpretation which Germany has largely outgrown.* A similar danger threatens every other country in which the clergy pursue a similar policy. No thinking man, whatever may be his religious views, can fail to regret this. A thoughtful, reverent, enlightened clergy is a great blessing to any country; and anything which undermines their legitimate work of leading men out of the worship of material things to the consideration of that which is higher, is a vast misfortune.

But, before concluding this part of the subject, it may be instructive to note a few special attempts at truces or compromises, such as always appear when the victory of any science becomes sure. Typical among the latest of these may be mentioned the attempt of Carl von Raumer in 1819. With much pretension to scientific knowledge, but with aspirations bounded by the limits of Prussian orthodoxy, he made a labored attempt to produce a statement which, by its vagueness, haziness, and "depth," should obscure the real questions at issue. This statement appeared in the shape of an argument, used by Bertrand and others in the previous century, to prove that fossil remains of plants in the coal-measures had never existed as living plants, but had been simply a "result of the development of imperfect plant embryos"; and the same misty theory was suggested to explain the existence of fossil animals without supposing the epochs and changes required by geological science.

In 1837 Wagner sought to uphold this explanation; but it was so clearly a mere hollow phrase, unable to bear the weight of the facts to be accounted for, that it was soon given up.

Similar attempts were made throughout Europe, the most noteworthy appearing in England. In 1853 was issued an anonymous work, having as its title "A Brief and Complete Refutation of the Anti-Scriptural Theory of Geologists": the author reviewed an old idea, but put a spark of life into it—this idea being that "all the organisms found in the depths of the earth were made on the first of the six creative days, as models for the plants and animals to be created on the third, fifth, and sixth days." †

* For these statements regarding Germany the writer relies on his personal observation as a student at the University of Berlin in 1856, as a traveler at various periods afterward, and as Minister of the United States in 1879, 1880, and 1881.

† See Zöckler, vol. ii, p. 475.

But, while these attempts to preserve the old theory as to fossil remains of lower animals were thus pressed, there appeared upon the geological field a new scientific column far more terrible to the old doctrines than any which had been seen previously.

For, just at the close of the first quarter of the nineteenth century, geologists began to examine the caves and beds of drift in various parts of the world; and, within a few years from that time, a series of discoveries began in France, in Belgium, in England, in Brazil, in Sicily, and in India which have established the fact that a period of time much greater than any which had before been thought of had elapsed since the first human occupation of the earth. The chronologies of Archbishop Usher, Petavius, Bossuet, and the other great authorities on which theology had securely leaned, fell. It was clearly seen that, no matter how well based upon the Old Testament genealogies and lives of the patriarchs, all these systems must go for nothing. The most conservative geologists were gradually obliged to admit that man had been upon the earth not merely six thousand, or sixty thousand, or one hundred and sixty thousand years. A very moderate estimate has made the time that the evolution of human civilization under the guidance of man has required fully a quarter of a million of years.*

The supporters of a theory based upon the letter of Scripture, who had so long taken the offensive, were now obliged to fight upon the defensive and at fearful odds. Various lines of defense were taken; but perhaps the most pathetic effort was that made in the year 1857, in England, by Gosse. As a naturalist he had rendered great services to zoölogical science, but he now concentrated his energies upon one last effort to save the literal interpretation of Genesis and the theological structure built upon it. In his work entitled "Omphalos" he developed the theory previously urged by Granville Penn, and asserted a new principle, called "prochronism." In accordance with this, all things were created by the Almighty hand literally within the six days, each made up of "the evening and the morning," and each great branch of creation was brought into existence in an instant. Accepting a declaration of Dr. Ure, that "neither reason nor revelation will justify us in extending the origin of the material system beyond six thousand years from our own days," Gosse held that all the evidences of convulsive changes and long epochs in strata, rocks, minerals, and fossils are simply "*appearances*"—only that and nothing more. Among these mere "appearances," all created instantaneously, were the glacial furrows and scratches on rocks, the marks of retreat seen in the wearing away of rocky masses, as at Niagara, the tilted and twisted strata, the piles of lava from extinct volcanoes, the fossils of every sort in every part of the earth, the foot-tracks of birds and reptiles, the half-

* See Professor Marsh's address as President of the Society for the Advancement of Science, in 1879.

digested remains of weaker animals found in the fossilized bodies of the stronger, the marks of hyenas' teeth on fossilized bones found in various caves, and even the skeleton of the Siberian mammoth at St. Petersburg with lumps of flesh bearing the marks of wolves' teeth—all these, with all gaps and imperfections, he urged mankind to believe came into being in an instant. The preface of the work is especially touching, and ends with the prayer that science and Scripture may be reconciled by his theory, and "that the God of truth will deign so to use it, and if he do, to him be all the glory." † And at the close of the whole book he declares: "The field is left clear and undisputed for the one witness on the opposite side, whose testimony is as follows: "In six days Jehovah made heaven and earth, the sea, and all that in them is." This quotation he placed in capital letters, as the final refutation of all that the science of geology had built.

In other parts of Europe desperate attempts have been made in recent times to save the letter of our sacred books by the revival of a theory in some respects more striking. To shape this theory to recent needs, vague reminiscences of a text in Job regarding fire beneath the earth, and vague conceptions of speculations made by Humboldt and Laplace, were mingled with Jewish tradition. Out of the mixture thus obtained Schubert developed the idea that the Satanic "principalities and powers" formerly inhabiting our universe plunged it into the chaos from which it was newly created by a process accurately described in Genesis. Rougemont made the earth one of the "morning stars" of Job, reduced to chaos by Lucifer and his followers, and thence developed in accordance with the nebular hypothesis. Kurtz evolved from this theory an opinion that the geological disturbances were caused by the opposition of the Devil to the rescue of our universe from chaos by the Almighty. Delitzsch put a similar idea into a more scholastic jargon; but most desperate of all were the statements of Dr. Anton Westermeyer, of Munich, in his "The Old Testament vindicated from Modern Infidel Objections." The following passage will serve to show his ideas: "By the fructifying brooding of the Divine spirit on the waters of the deep, creative forces began to stir; the devils who inhabited the primeval darkness and considered it their own abode saw that they were to be driven from their possessions, or at least that their place of habitation was to be contracted, and they therefore tried to frustrate God's plan of creation and exert all that remained to them of might and power to hinder or at least to mar the new creation." So came into being "the horrible and destructive monsters, these caricatures and distortions of creation," of which we have fossil remains. Dr. Westermeyer goes on to insist that "whole generations called into existence by God succumbed to the corruption of the Devil, and for that reason had to be destroyed"; and that

† See Gosse, "Omphalos," London, 1857, p. 5, and *passim*; and for a passage giving the key-note of the whole, with a most farcical note on coprolites, see pp. 353, 354.

"in the work of the six days God caused the devil to feel his power in all earnest, and made Satan's enterprise appear miserable and vain." *

Such is the last important assault upon the strongholds of geological science in Germany; and, in view of this and others of the same kind, it is little to be wondered at that, when, in 1870, Johann Silberschlag made an attempt to again base geology upon the Deluge of Noah, he found such difficulties that, in a touching passage, he expressed a desire to get back to the theory that fossils were "sports of Nature." †

But the most noted among efforts to keep geology well within the letter of Scripture is of still more recent date. In the year 1885 Mr. Gladstone found time, amid all his labors and cares as the greatest parliamentary leader in England, to take the field in the struggle for the letter of Genesis against geology.

On the face of it his effort seemed Quixotic, for he confessed at the outset that in science he was "utterly destitute of that kind of knowledge which carries authority," and his argument soon showed that this confession was entirely true.

But he had some other qualities of which much might be expected —great skill in marshaling words, great shrewdness in adapting the meanings of single words to conflicting necessities in discussion, wonderful power in erecting showy structures of argument upon the smallest basis of fact, and a facility almost preternatural in "explaining away" troublesome realities. So striking was his power in this last respect that a humorous London chronicler once stated that a bigamist had been advised, as his only hope, to induce Mr. Gladstone to "explain away" one of his wives.

At the basis of this theologico-geological structure, Mr. Gladstone placed what he found in the text of Genesis: "A grand four-fold division" of animated Nature "set forth in an orderly succession of times," and he arranged this order and succession of creation as follows: "First, the water population; secondly, the air population; thirdly, the land population of animals; fourthly, the land population consummated in man."

His next step was to slide in upon this basis the apparently harmless proposition that this division and sequence "is understood to have been so affirmed in our time by natural science that it may be taken as a demonstrated conclusion and established fact."

Finally, upon these foundations he proceeded to build an argument out of the coincidences thus secured between the record in the Hebrew sacred books and the truths revealed by science as regards this order and sequence, and he easily arrived at the desired conclusion with

* See Shields's "Final Philosophy," pp. 340 *et seq.*, and Reusch's "Nature and the Bible" (English translation, 1886), vol. i, pp. 318–320.

† * See Reusch, vol. i, p. 264.

which he crowned the whole structure, namely, as regards the writer of Genesis, that "his knowledge was divine." *

Such was the skeleton of the structure; it was abundantly decoated with the rhetoric in which Mr. Gladstone is so skillful an artificer, and it towered above "the average man" as a structure beautiful and invincible—like some Chinese fortress in the nineteenth century, faced with porcelain and defended with bows and arrows.

But its strength was soon seen to be unreal. A single shot from a leader in the army of science wrecked it. In an essay admirable in its temper, overwhelming in its facts, and absolutely convincing in its argument, Professor Huxley, late President of the Royal Society, and doubtless the most eminent living authority on the scientific questions concerned, took up the matter.

Mr. Gladstone's first proposition, that the sacred writings give us a great "fourfold division" created "in an orderly succession of times," Professor Huxley did not presume to gainsay.

But, as to Mr. Gladstone's second proposition, that "this great fourfold division . . . created in an orderly succession of times . . . has been so affirmed in our own time by natural science that it may be taken as a demonstrated conclusion and established fact," Professor Huxley showed that, as a matter of fact, no such "fourfold division" and "orderly succession" exist; that, so far from establishing Mr. Gladstone's assumption that the population of water, air, and land followed each other in the order given, "all the evidence we possess goes to prove that they did not"; that the distribution of fossils through the various strata proves that some land animals originated before sea animals; that there has been a mixing of sea, land, and air "population" utterly destructive to the "great fourfold division" and the creation "in an orderly succession of times"; that so far is the view presented in the sacred text, as stated by Mr. Gladstone, from having been "so affirmed in our own time by natural science, that it may be taken as a demonstrated conclusion and established fact" that Mr. Gladstone's assertion is "directly contradictory to facts known to every one who is acquainted with the elements of natural science"; that Mr. Gladstone's only geological authority, Cuvier, had died more than fifty years before, when geological science was in its infancy [and he might have added, when it was necessary to make every possible concession to the Church], and, finally, he challenged Mr. Gladstone to produce any contemporary authority in geological science who would support his so-called scriptural view. And, when in a rejoinder Mr. Gladstone attempted to support his view on the authority of Professor Dana, Professor Huxley had no difficulty in showing from Professor Dana's works that Mr. Gladstone's inference was utterly unfounded.

* See Mr. Gladstone's "Dawn of Creation and Worship," a reply to Dr. Réville, in the "Nineteenth Century," for November, 1885.

Both the scientific and theological world remained silent; there was nothing more to be said.

This being the case, Mr. Gladstone's wonderful fabric of coincidences between the "great fourfold division" in Genesis and the facts ascertained by geology fell of themselves. Professor Huxley's blow had shattered the central proposition—the key-stone of the supporting arch—and the last great fortress of the opponents of unfettered scientific investigation was in ruins.

But, in opposition to this attempt by a layman, we may put a noble utterance by a clergyman who has probably done more to save what is essential in Christianity among English-speaking people than any other ecclesiastic of his time. The late Dean of Westminster, Dr. Arthur Stanley, was widely known and beloved on both continents. In his memorial sermon after the funeral of Sir Charles Lyell he said: "It is now clear to diligent students of the Bible that the first and second chapters of Genesis contain two narratives of the creation side by side, differing from each other in almost every particular of time and place and order. It is well known that, when the science of geology first arose, it was involved in endless schemes of attempted reconciliation with the letter of Scripture. There was, there are perhaps still, two modes of reconciliation of Scripture and science, which have been each in their day attempted, *and each has totally and deservedly failed.* One is the endeavor to wrest the words of the Bible from their natural meaning and *force it to speak the language of science.*" And again, speaking of the earliest known example, which was the interpolation of the word "not" in Leviticus xi, 6, he continues: "This is the earliest instance of *the falsification of Scripture to meet the demands of science;* and it has been followed in later times by the various efforts which have been made to twist the earlier chapters of the book of Genesis into *apparent* agreement with the last results of geology—representing days not to be days, morning and evening not to be morning and evening, the Deluge not to be the Deluge, and the ark not to be the ark."

After a statement like this we may fitly ask: Which is the more likely to strengthen Christianity for its work in the twentieth century which we are now about to enter—a large, manly, honest, fearless utterance like this of Arthur Stanley, or hair-splitting efforts, bearing in their every line the germs of failure, like that made by Mr. Gladstone?

The world is finding that the scientific revelation of creation is ever more and more in accordance with worthy conceptions of that great Power working in and through the universe. More and more it is seen that inspiration has never ceased, and that its prophets and priests are not those who work to fit the letter of its older literature to the needs of dogmas and sects, but those who patiently,

fearlessly, and reverently devote themselves to the search for truth as truth, in the faith that there is a Power in the universe strong enough to make truth-seeking safe and good enough to make truth-telling wise.

UNDERGROUND WATERS AS SOCIAL FACTORS.

By Professor G. A. DAUBRÉE,
MEMBER OF THE FRENCH ACADEMY OF SCIENCES.

FROM the most remote times, the beneficent springs that jet from the interior of the earth have excited the gratitude and admiration of men. Like the sea and rivers, they have been deified by the peoples of the Indo-European family; and the worship that has been given to them, and the fables with which superstition has invested them, express the degree to which popular imagination has been struck by their mysterious origin, their inexhaustible flow, and their secret properties. The Greeks attributed to the fountain of Dodona, in Epirus, the faculty of discovering hidden truths and uttering oracles. The fountain of Egeria was supposed to possess the same power, and was intrusted to the guardianship of the Vestal Virgins. The fountains of Castalia, on the flank of Parnassus, and of Hippocrene, near Helicon, were believed to communicate the poetic spirit.

The Gauls had special veneration for the springs to which they went in search of health. The old romances of chivalry in their fancies of a fountain of youth, where spent forces and lost charms could be recovered, were only reproducing a myth of old Greece.

The perennial nature of springs, which was for a long time regarded as a sacred mystery, was also their most striking characteristic to those who sought to explain it without reference to religion and poetry. According to Aristotle's idea, which was adopted by Seneca and prevailed till the sixteenth century, "the interior of the earth contains deep cavities and much air, which must necessarily be cooled there. Motionless and stagnant, it is not long in being converted into water, by a metamorphosis like that which, in the atmosphere, produces rain-drops. That thick shadow, that eternal cold, that condensation which is disturbed by no movement, are the always subsisting and incessantly acting causes of the transmutation of air."

Simple and manifest as it appears to us now, the origin of springs was late in being recognized. Vitruvius suspected it, in his work on architecture; but it was Bernard Palissy who, after long studies on the constitution of the country in which he lived, overthrew the ancient fancies. According to his "Admirable Discourse on the Nature of Waters and Fountains, both Natural and Artificial," springs are generated by the infiltration of rain-waters or melted snow toward the interior of the earth, through cracks, till they reach "some place having a

bottom of stone or contiguous rock." Palissy further sought means for establishing artificial fountains "in imitation of nature and as nearly approaching it as possible, by following the method of the sovereign Fountain-maker." He added the profound thought, which lies to-day at the foundation of experimental geology, "It is impossible to imitate Nature in anything, except we first contemplate her effects, and take her for our pattern and example." Hence we understand why springs are inexhaustible, because they are unceasingly renewed by the play of permanent forces; they result from a circulation which is in some respects symmetrical with the great aërial circulation of water.

Violent phenomena, like earthquakes, have certainly the prerogative of exciting the imagination. But other phenomena, though they take place slowly and in silence, are none the less worthy of interest; of this character are the mechanism and the fruitful action of the subterranean waters, of which springs are the exterior manifestation. Aside from their usefulness to man, the importance of the study of them is all the greater in that their work is not alone applicable to the present time. Since the crust of the earth has existed, and during all the periods of its development, the water circulating within it, sometimes at very high temperatures, has produced considerable and varied effects, which have in one way or another durably registered themselves, and the explanation of which is facilitated by recent experiments. It is, in fact, this incessant circulation which has engendered a large number of mineral species. The present functions of underground waters will first engage our attention, the examination of their part in the formation of minerals in ancient epochs being reserved for future studies.

As the course of rivers depends on the exterior contours of the soil, so is the *régime* of subterranean waters an immediate consequence of the nature and mode of arrangement of the masses through which they move.

Except for a very thin covering of vegetable soil, which is a kind of epidermis, the crust of the earth is composed of materials to which the name of rocks is applied, even when, like sand and clay, they are of little coherency. All of these masses have been formed successively, during periods of extremely long duration, and in the midst of conditions of which they bear in themselves the characteristic marks. They are veritable monuments, which delineate in their essential traits the successive revolutions of our globe.

The rocks constituting the greater part of the continents are called stratified, because they are divided into large parallel layers, to which are given the name of strata or beds. It is certain that the rocks of this category, whatever their composition, have been formed in the seas or lakes by sediments and organisms: a sure proof of this truth is furnished by their pebbles and sands, the origin of which can

not be different from that of the present deposits of the ocean; the innumerable remains of fossilized marine animals are a still more eloquent testimony to it; and the disposition in beds completes the analogy with contemporaneous sediments. All of these formations may be traversed by mineral masses, disposed in more or less vertical irregular veins, which are usually contrasted in character to the incasing parts. Having risen from very deep regions, they are designated as eruptive rocks.

Some among these various materials are impervious to the passage of water. One of the most so among them is clay, a very abundant hydrated silicate of alumina, which, mixed with carbonate of lime, is also abundant as marl. Granite, and similar rocks, such as the schists, of which slate represents a well-known variety, have the same property, provided the fissures that traverse them are not too open. Thus, although the incessant invasion of water constitutes one of the chief obstacles to the miner's work, there are exploitations that keep quite dry in consequence of the impermeability of the incasing masses.

Other materials are easily permeable by water, as we may observe every day in sand and gravel. The same is the case with rocks which, not being themselves porous, are cut and cross-cut by crevices. Many compact limestones give instantaneous passage to water, which is drained away by their crevices as it would be by artificial conduits.

The *régime* of subterranean waters is exhibited in simple and clear characters in the deposits known as the ancient alluviums, the drift, and the quaternary deposits, which cover most of the continents as with a carpet. Their gravels and sands, usually associated with clays, greedily absorb water into interstices which represent a notable fraction (perhaps a third) of their total volume. Arrested in its descent by impermeable masses, it accumulates and forms a sheet or shallow body, from which it may be seen to exude through all the openings that may be made into it. This sheet has received several common names: as in France, *nappe des puits* (well-water) and *nappe d'infiltration* (infiltration-water); in Germany, *Grundwasser;* in England, ground-water; and in Italy, *acqua di suolo, acqua di livello.* A Greek term, which is cosmopolitan, is preferable, and it is found in the word *phreatic.* In a horizontal direction, the phreatic waters may occupy extensive surfaces, even whole countries, like the arenaceous deposits that serve as their receptacle.

An artificial excavation is not always necessary to make manifest the existence of ground-water. It appears in natural hollows of the soil, takes advantage of ravines of slight depth to issue in springs, which are sometimes impetuous and voluminous enough to constitute considerable streams at their source. The great sheet of the plain of Lombardy thus discharges itself into the beds of the rivers which plow the land in such a way that, after the streams have been drained by numerous irrigation-canals, they rise again spontaneously a little

farther down, without apparently having received any new supply. The inexhaustible abundance of this interior sheet also receives here an agricultural application which is, perhaps, to the present time, unique. The water which is drawn from it by means of shallow wells called *fontanelle* is, in consequence of its nearly constant temperature, which is higher in winter than that of the ambient air, eminently suitable for irrigation. By forcing it to flow constantly in a thin sheet over the ground, the peasants are able, in a cold country, to cut their grass in January as in the summer-time. There are more than a thousand of these artificial subsoil springs, occupying a zone about two hundred kilometres long, extending from Ticino to Verona.

All rocks which are penetrable to water by means of fissures are also capable of containing phreatic water. The water in these sheets is not stagnant, but is animated by a slow and continuous motion. Among the facts that prove this we may cite the transportation in the subsoil of impurities like coal-tar, in the same direction, over several hundred metres, in a series of wells, the alignment of which marks the direction of the current. This movement is due to the general incline of the sheet.

In volcanic masses, the scoriaceous dejections and the lava-flows, with their cavities of various dimensions, offer no less facility for infiltrations. Rain-waters penetrate them and reappear lower down. Among the flows of fifty volcanoes in Auvergne, that which issues from the Puy de Gravenoire, near Clermont, gives rise to three springs: first at Fontanat; then at Royat, where they issue from a cave opened in the scoria surmounted by prismatic lava; and at the lower end of the flow the water is discharged under similar conditions to the advantage of the city of Clermont. In the same way, after having formed at Murois those scoriaceous caves to which George Sand has lent an infernal aspect, the long flow of the Tartaret gives out in its course a series of springs, around which several villages have grouped themselves. Thus fire is found to prepare the way for water by creating subterranean conduits for it.

The natural action of the waters which we have studied in the superficial deposits is indicated with equal clearness at a greater depth, in the midst of the stratified rocks. In these last, in fact, certain beds, very penetrable to water, alternate with others which arrest its passage. Whether the beds be horizontal or inclined, the relief of the soil is frequently so gashed that the impermeable support of the filtering and water-bearing stratum crops out and determines a flow by virtue of hydrostatic laws. These natural reservoirs thus produce springs which are permanent, provided successive rains furnish a sufficient supply of water, while they also sometimes simply give place to irregular oozings. These effusions occur not on the continents only, but also in sea-basins.

The sedimentary rocks, in their great thickness, inclose a succes-

sion of water-sheets or water-levels occupying distinct stages, and extending, with uniform characters, under whole countries, like the strata to which they are subordinated. It is proper to remark here that by the term water-sheet is not meant a real bed of water, lodged in a cavity, between solid masses that serve as walls to it, but water filling the minute interstices or the cracks of a rock. Continuous and regular in sand, these sheets are usually discontinuous and irregular in limestones and sandstones, in which the water only occupies more or less spacious fissures. When natural issues are wanting, human industry is able, by boring, to make openings down to the subterranean waters, which it causes to jet up to the surface, and sometimes to a considerable height above. The thought of undertaking such works is a very ancient one. The Egyptians had recourse to them forty centuries ago; and they were executed in France, in 1126, at Artois, whence the name of artesian wells has been given to them.

The water-levels of the cretaceous strata, from which the French artesian waters issue, are not always of advantage; but in the north of France and in Belgium they constitute the most formidable obstacle which miners have to encounter in reaching the coal-beds.

A striking confirmation of the theory of the source of supply of the artesian waters has been observed at Tours, where the water, spouting with great velocity from a well a hundred and ten metres in depth, brings up, together with fine sand, fresh-water shells and seeds, in such a state of preservation as to show that they could not have been more than three or four months on their voyage. Some of the wells of the wady Rir have also ejected fresh-water mollusks, fish, and crabs, still living, which must, therefore, have made a still more rapid transit. Caves, in limestone regions, play a part of the first order in the movements of the interior waters. Their presence is manifested at the surface by depressions of various shapes, such as are called "swallow-holes" in the north of England, and "sink-holes" in the United States. These cavities draw in the surface-waters and remove them from sight, to reappear at some other place, oftentimes in exceptionally voluminous fountains. They can be pointed out by the hundred in some parts of France, although only a small proportion of them are revealed by a visible discharge. The internal hollows are often aligned with dislocations of the ground, with which they are connected as effects of fractures, ultimately corroded and rounded off by water. The caves of Baume in the chain of the Jura correspond with a series of tunnel-holes and sinkings from the prolongation of which arises the river Seille. The Jurassic limestone of La Charente is marked by pits of various depths, with yawning mouths, into which the Tardouère and the Baudiat disappear near La Rochefoucauld, to gush out bubbling farther down and give rise to the Tourne. In the departments of the Var and the Maritime Alps, numerous sink-holes (*scialets*) feed, through secret channels, powerful springs that issue from the sea-

bottom not far from the shore. The limestone around Mont Ventoux is riddled in a zone of seventy kilometres by natural wells and unfathomable pits, many of which bear names well known in the local legends. The waters which these rocks have stored up are poured out at their lowest point, and give rise, in a picturesque grotto, to the copious fountain of Vaucluse, which was formerly regarded as a beneficent divinity. Compared with the depth of the rains at different stations in the basin, the mean outflow of the fountain indicates a volume of infiltration equal to about six tenths of the quantity of rain-water. The limestone under the valley of the Loire, at Orleans, is plowed by interior currents from which the water-supply of the city is directly taken. The waters begin to be lost at a point some forty kilometres above the city, and return to the river about thirty kilometres below. The Iton, in the department of the Eure, fails to flow over the surface for several kilometres, and is called the Sec-Iton, or dry Iton; but its waters are reached in their subterranean course by excavations of twenty metres. Similar facts may be observed in all parts of the globe. By a similar kind of drainage the cavernous limestone of the Apennines gives rise to the Aqua Martia, which was brought to Rome B. C. 608 by the consul Quintus Marcius, and which still continues to be of prime importance to the city; "the most celebrated water in the universe," enthusiastically says Pliny, "a franchise of salubrity, one of the benefits granted to Rome by the favor of the gods."

A grain of truth sometimes lies at the bottom of the ancient fictions. Was not the observation of water-courses which are ingulfed and appear again the origin of the fable of the fountain of Arethusa, which the Greeks regarded as the reappearance of the river Alpheus? After a pursuit from Peloponnesus across the Ionian Sea, it was supposed to overtake the nymph personified in this fountain at the moment when it gushed out near Syracuse.

Besides moving through the interstices, fissures, and cavities of the crust of the globe, water exists everywhere in another state, in which, although quite invisible, it is of hardly less importance. All rocks, including the most compact ones, inclose water within their pores, however minute they may be, where it is held by capillary attraction, and is not apparent to our instruments of highest magnifying power. But it may be disengaged by desiccation, when the rock will be found to have lost a sensible fraction, some ten thousandths at least, of its weight. At the same time some of the qualities of the rock are modified; for workers in slate, sandstone, and other rocks find it a matter of great difference, in the facility of their tasks, whether these stones still hold their quarry-water or have been dried in the air. The Romans availed themselves of the porosity of the onyx to soak it in certain liquids which would enliven the color of the stones that they used in their cameos. Under this form of intimate latent impregnation,

though relatively in extremely feeble proportions, water is incorporated in the deep masses of the terrestrial crust, in immense absolute quantities, which are perhaps commensurable with the volume contained in the seas on the surface.

Various physical circumstances, such as the configuration of the soil and the vicinity of rivers or of the sea, have always had a great influence on the grouping and destinies of populations. The presence of particular minerals has had a similar determining influence. The useful metals, coal, and petroleum, have caused important cities to be created and to grow—as Virginia City, Leadville, Eureka, Oil City, and Petrolia, in the United States.

Underground water, a more commonplace substance, which has attracted much less attention, eminently deserves to be considered when we seek for the natural causes that have contributed to the formation of large agglomerations of men. Pliny the Elder remarked that mineral waters had peopled the earth with new cities and Olympus with new gods. Recent excavations in Gallic villages have brought to light vast *piscinæ*, marble monuments, theatres, statues, mosaics, and other unmistakable vestiges of a vanished luxury, as at Nereis, Vichy, Plombières, Bagnères-de-Luchon, and Aix in Provence. Universal celebrity attaches to Baiæ, where every Roman was ambitious to have a country-house, and the ancient splendor of which is attested by ruined temples and palaces. The word "bath" and its equivalents in different languages form the roots of many place-names. Those who lived by the manufacture of salt have necessarily grouped themselves around the marine springs from which their towns have received names embodying the root-form of the word salt or its equivalents —Salins, Chateau-Salins, Salival, Marsal, Salies, Salat, Saleons, Saltz, Saltzbronn, Salzhausen, Salzungen, Salzburg, Hall, Reichenhall, etc.

So populations tend to group themselves around copious fountains of fresh, potable water, where the frequency of the villages is often in striking contrast with the sparsity of the settlements in more arid localities. These contrasts result from the constitution of the soil. The junction of the Jurassic formation with the impermeable clays of the lias on which it rests is marked by a line of frequent springs, around which habitations and villages stand thickly, as in the vicinity of Metz; while the absence of masses of population on the neighboring limestones, where water is reached only at a great depth, is matter of special remark. This abundant and regular water-supply is found under these conditions, and at the same geological level, in many parts of France, England, and Germany, where it always attracts thick populations.

While the cretaceous table-lands of Champagne lack springs, they flow out in abundance at the foot of the cliffs. Many of them bear the generic name of "Somme," because they are the origin or the top of a brook—as Somme-Suippe, Somme-Vesle, Somme-Tourbe, Somme-

Bionne, and some fifty others. Around these springs, not far from arid and almost desert regions, are situated villages which gratefully borrow their names from the waters to which they owe their life; a kind of paternity which is not rare. In France numerous places, such as Fontainebleau, Fontanat, Fontanille, Fontvannes, Fontoy, Fontenoy, and Fontanay, derive their names from the Latin words *fons* and *fontanetum*, and some names are repeated many times. The same fact is apparent in Italy and Spain, where more than eight hundred names have the same origin; also in Germany, where the forms Brun, Bronn, and Born occur. The city of Paderborn is built upon forty springs which give rise to the Pader. Not far away is Lippspring, a word expressing the origin of the Lippe. This word "spring" in England and the United States, and "ain" in the north of Africa, convey the same idea. Eau, Aix, Aigues, Acqua, Aqua, and Waters, figure likewise in many words, with the signification of spring-water.

Nothing more clearly exemplifies the attractive force of subterranean waters than those collections of tilled-lands and habitations among the oases that are scattered over deserts. Strabo compared the Sahara to a panther's skin, the ground of which is the desert, while the black spots correspond with the somber verdure of the oases. These spots are aggregated in groups, like archipelagoes in the sea, in a zone of that desert which is confined between the thirtieth and thirty-seventh degrees of latitude. Algeria contains more than three hundred of them. Certain rainy regions, like Mount Atlas, send water by underground routes, which reaches them through sandy beds contained between impermeable strata of clay, and is thus protected against evaporation. Sometimes, when the water-sheet is not very deeply situated, it is utilized by digging holes where the roots of the palm-trees have grown down toward it. At many other points the water, impelled by the pressure upon it, opens a passage to the surface, and gives rise to springs or natural artesian wells. These appearances of water in the midst of arid and desert steppes constitute centers around which a life has developed itself under the protection from the sun and the simoom afforded by the palm and fruit trees. From a very remote epoch the natives have known how to imitate nature by opening issues for the interior water-sheet; but the perilous labor of digging was not inviting to workmen, and many of the ancient wells have become obstructed. The villages have become depopulated for want of water, the oases have shrunk, and gradually the desert has resumed the possession of the soil.

The first well bored after the French occupation of Algeria, at Tamema, spouted on the 19th of June, 1856, and was blessed by a marabout under the name of the Fountain of Peace. Numerous other borings revealed the existence of an underground river lying for a distance of a hundred and thirty kilometres beneath the wady Rir. At present one hundred and seventeen bored wells, together with five hundred

native wells, give exit, from a mean depth of seventy metres, to a volume of water fully equal to that of the Seine, at Paris, in its lowest stage. Cultivated lands have been created, the native population has doubled, and the value of the oases has more than quintupled; a complete transformation of this part of the Sahara has been effected, by the agency of underground waters, within thirty years. Most of the manufacturing cities of the middle and north of England are situated upon the New Red Sandstone, where, besides excellent building-stone and proximity to the coal-fields, they enjoy the inestimable advantage of the presence of inexhaustible reservoirs of water purified by natural filtration, and easy of extraction. Belfast, in Ireland, is similarly situated. The water-bearing gravels are particularly worthy of attention from this point of view. With the inexhaustible and easily accessible provisions of water which they contain, they present to man an almost infinite expansion. This accounts for the existence upon these deposits, from most ancient times, of numerous important cities and capitals, like London, Paris, and Berlin. But in London the arenaceous and phreatic stratum has limitations which were opposed for several centuries to growth in particular directions. For a long time, according to Mr. Prestwich's observations, the population, by an instinct easy to understand, continued strictly concentrated on the principal water-sheet, and on a few isolated strips of gravel, as at Islington and Highbury. In the suburbs, likewise, the thick populations were collected on the larger gravel-beds rich in water, while in the same region, although the soil was everywhere cultivated and productive, the houses were very sparsely scattered. But the situation has greatly changed within the last seventy years, a supply of water having been brought from a distance, and the city has spread very rapidly over the clayey grounds.

Numerous populations still depend on wells for their drinking-water; Lombardy and Venice, with two million inhabitants; the extensive plains of Hungary; at least half of the German Empire; a part of the Russian Empire, seven times as large as France, and populated by about twelve million souls; and, according to the explorer Abbé David, the whole of the great northern plain of the Chinese Empire, containing more than a hundred million inhabitants. Besides these vast plains which represent more than a third of the continents, there are numberless valleys, with water-bearing subsoils, which have attracted to themselves aggregations of men. We can then affirm that a very important fraction of the human race depends for its principal drink wholly upon water which is furnished by the phreatic strata of ancient or modern alluviums. We never find such concentrations of inhabitants in countries where the soil is formed from granitic and schistose rocks, without being covered by disaggregated materials. These rocks permit water to descend to their interior only with the greatest difficulty. Springs are likewise weak among them, but very numerous; and the

population is by force disseminated among them in isolated houses, and constitutes at most only little hamlets. The inhabitants, thus dispersed, differ in manners and character from those whom an indefinite abundance of underground water has drawn together and condensed into large groups.

Such are some of the social influences of subterranean waters, the importance of which has not always been fully appreciated.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

GLIMPSES AT DARWIN'S WORKING LIFE.

By WILLIAM H. LARRABEE.

THE qualities of Mr. Darwin most prominently brought out in the reading of his "Life and Letters" are his thorough humanism, his industry, his great modesty, amounting to even distrust of his powers, his perfect candor, and his kindly spirit. The piece of his autobiography which was published in the December number of the "Monthly" describes the beginning of his life, and shows how his boyhood was like that of the youth of the majority of men, with nothing in it to suggest a probability of future greatness; a commonplace, humdrum experience, in which all his most active instincts were repressed or ignored; and he was "trained"—that is, the effort was made, with his consent or against it, to fit him to the standard handed down from of old by the schools. As he wrote years afterward for Mr. Galton's "Life Histories," his schooling omitted all habits of observation or reasoning, and was of no peculiar merit whatever. He was considered, by those who had to do with him educationally, as "a very ordinary boy, rather below the common standard of intellect." It does not appear that he ever realized, until the world spoke it to him in tones that he could not fail to hear, that, in all his researches, he was doing more than the simplest, most insignificant work.

He fared but little better, so far as the recognized course was concerned, at the university (of Edinburgh), where the lectures, except those of Dr. Hope on chemistry, were "intolerably dull." But, during his second year there, his brother having ceased to attend the university, he was left to his own resources; and this proved to be to his advantage, for he became well acquainted with several young men fond of natural science. He accompanied a pair of his friends on their collecting tours for marine animals, and went trawling with the fishermen for other specimens. From some of these specimens, though without any regular practice in dissection, and having only a wretched microscope, he made a discovery, concerning which he read, in 1826, his first scientific paper before the Plinian Society. With these experiences as his start in real education, he told Mr. Galton that he con-

sidered that all that he had learned of any value had been self-taught. He found an unnamed professor's lectures on geology and zoölogy so intolerably dull that they produced on him as their sole effect the determination never, so long as he lived, to read a book on geology, or in any way to study the science. Happily, this determination gave way, under associations with more genial geologists and in the presence of geological phenomena.

From Edinburgh he went to Cambridge, where he was a ready listener to Professor Henslow's lectures on botany, associated with a "sporting set," became interested in pictures and music (for which he had no ear), and was fascinated with the passion for collecting beetles. "I am surprised," he says, "what an indelible impression many of the beetles which I caught at Cambridge have left on my mind. I can remember the exact appearance of certain posts, old trees, and banks where I made a good capture."

Darwin mentions his friendship with Professor Henslow as a circumstance which influenced his career more than any other. The professor kept open house once every week, which Darwin frequented regularly, and they became companions on long walks, so that he was known as "the man who walks with Henslow." Through Henslow Darwin formed the acquaintance of several other eminent men, the privilege of having associated with whom suggested to him, looking back from many years later in life, that there must have been something in him a little superior to the common run of youths, or else they would not have taken to him. "Certainly," he says, "I was not aware of any such superiority, and I remember one of my sporting friends, Turner, who saw me at work with my beetles, saying that I should one day be a Fellow of the Royal Society, and the notion seemed to me preposterous."

Professor Henslow's friendship secured a recommendation of Darwin to Captain Fitzroy, who was about to start on the famous expedition of the Beagle around the globe, "as amply qualified for collecting, observing, and noting anything worthy to be noted in natural history." The elder Darwin objected to his son's going, chiefly because he was intending to become a clergyman, and the voyage might end in withdrawing him from that profession; and Darwin came very near being rejected by Captain Fitzroy on account of the shape of his nose. The father's objections were overcome by means of the representations of Darwin's uncle, Josiah Wedgwood, and Fitzroy's by further acquaintance. The voyage, the story of which is familiar, was on the whole happy and instructive, and was marked by Darwin as by far the most important event in his life, and one which determined his whole career; and to it he always felt that he owed the first real training or education of his mind. But one sequence of it is to be deplored: he returned a permanent invalid. Of the scientific aspect of the voyage he speaks: "I also reflect with high satisfaction on some of

my scientific work, such as solving the problem of coral islands, and making out the geological structure of certain islands, for instance, St. Helena. Nor must I pass over the discovery of the singular relations of the animals and plants inhabiting the several islands of the Galapagos Archipelago, and of all of them to the inhabitants of South America. As far as I can judge of myself, I worked to the utmost during the voyage from the mere pleasure of investigation, and from my strong desire to add a few facts to the great mass of facts in natural science. But I was also ambitious to take a fair place among scientific men—whether more ambitious or less so than most of my fellow-workers I can form no opinion."

Among the spoils brought home from the voyage were a number of specimens of fossil edentata, the discovery of which, says Mr. Francis Darwin, "has a special importance as a point in his own life, since it was the vivid impression produced by excavating them with his own hands that formed one of the chief starting-points of his speculation on the origin of species." Recording in July, 1837, the opening of the first note-book on transmutation of species, Darwin refers to the character of the fossils in the Galapagos Archipelago as the origin of all his views. In the early fall of 1837 he made his first observations on earth-worms, on which he based a paper in the Geological Society.

In September, 1838, while busy on his book on volcanoes and coral reefs, he wrote to Mr. Lyell concerning what was to be the grand achievement of his life: "I have lately been sadly tempted to be idle —that is, as far as pure geology is concerned—by the delightful number of new views which have been coming in thickly and steadily—on the classification and affinities and instincts of animals—bearing on the question of species. Note-book after note-book has been filled with facts which begin to group themselves *clearly* under sub-laws"; and to his cousin, W. D. Fox: "I am delighted to hear you are such a good man as not to have forgotten my questions about the crossing of animals. It is my prime hobby, and I really think some day I shall be able to do something in that most intricate subject, species and varieties." In another letter to Fox, he says: "The smallest contributions thankfully accepted; descriptions of offspring of all crosses between all domestic birds and animals, dogs, cats, etc., very valuable. Don't forget, if your half-breed African cat should die that I should be very much obliged for its carcass sent up in a little hamper for the skeleton; it, or any cross-bred pigeons, fowl, duck, etc., will be more acceptable than the finest haunch of venison or the finest turtle."

His eldest child was born in 1839, and he began upon him the observations which grew into the book on the "Expression of the Emotions." In October, 1846, Darwin informed Hooker that he was about to prepare some papers on the lower marine animals, after which he should begin looking over his ten-year-long accumulation of notes

on species and varieties, by reason of which, when published, "I dare say I shall stand infinitely low in the opinion of all sound naturalists." The papers referred to were the treatise on cirripedes, to which eight years, instead of the "some months" he had anticipated, were devoted. The importance of this labor was not fully appreciated at the time—"I hate a barnacle," he said once in his weariness over the task, "as no man ever did before, not even a sailor in a slow-sailing ship"—but Sir Joseph Hooker has written to Mr. Francis Darwin: "Your father recognized three stages in his career as a biologist: the mere collector at Cambridge; the collector and observer in the Beagle, and for some years afterward; and the trained naturalist after, and only after, the cirripede work. That he was a thinker all along is true enough, and there is a vast deal in his writings previous to the cirripedes that a trained naturalist could but emulate. . . . He often alluded to it as a valued discipline, and added that even the 'hateful' work of digging out synonyms, and of describing, not only improved his methods but opened his eyes to the difficulties and merits of the works of the dullest of cataloguers. One result was that he would never allow a depreciatory remark to pass unchallenged on the poorest class of scientific workers, provided that their work was honest, and good of its kind. I have always regarded it as one of the finest traits of his character—this generous appreciation of the hod-men of science, and of their labors, . . . and it was monographing the barnacles that brought it about."

Darwin's letters, during the time he was engaged upon the "Origin of Species" and the related works, reveal the minute care with which he examined every trifle of a detail, and sought information from every possible quarter. Here we see him inquiring of Mr. Fox how early the tail-feathers of young fantail pigeons are developed, and remarking upon the difference in the weight of the foot or the wing of a wild and a tame duck. He wants to ascertain whether the young of our domestic breeds differ as much from one another as do their parents, and has no faith in anything short of actual measurement and the rule of three. He asks for lizards' and snakes' eggs to see whether they will float on sea-water, and whether they will keep alive thus floating for a month or two in his cellar.

In similar experiments on seeds he is so full of exultant anticipation that he will discover something that will conflict with Hooker's views, that the children are asking him often whether he shall beat Dr. Hooker; and when the seeds have germinated after a salt-water soaking that ought to have killed them, he has pangs of conscience and of vexation because the botanist seemed "to view the experiment like a good Christian." Then he acknowledges Hooker to be a good man to confess that he expected the cress—which vegetated after twenty-one days' immersion—would be killed in a week, "for this gives me a nice little triumph." But he is also making experiments at which Hooker would have a good right to sneer, "for they are so

absurd, even in my opinion, that I dare not tell you." Everything—for he was trying to show that seeds and eggs could be carried on ocean-currents for indefinite distances and then develop—depended on the seeds floating. If, however, the seeds should sink, and sink after new trials, he would still not give up the floating, but, as a last resource, "must believe in the pod, or even whole plant or branch washed into the sea; with floods, and slips, and earthquakes, this must be continually happening, and, if kept wet, I fancy the pods, etc., would not open and shed their seeds." Again, he begins to think the floating question more serious than the germinating one, and is making all the inquiries he can on the subject. He tells how three plants have come up out of the earth perfectly inclosed in the roots of trees, and twenty-nine plants out of the tablespoonful of mud from the little pond; and how Hooker was struck when shown how much mud had been scraped off one duck's feet; these facts all being regarded as illustrating the ways in which seeds might have been transported to different islands. He thanks Wallace for an offer to look after horses' stripes; wants him to add donkeys, if there are any; and expresses a community of interest with him in bees' combs. He tries experiments on the struggle for existence with thick plantations of weeds in which the fate of each seedling is noted; and observes how young fir-trees flourish in ground that is fenced, while others, in the same plantation, unprotected from cattle, are invisible till closely looked for, and do not grow to be more than three inches high in twenty-six years.

While thus attentive to the minutest details of fact, he declares himself "a firm believer that without speculation there is no good and original observation"; and that "the naturalists who accumulate facts and make many partial generalizations are the *real* benefactors of science. Those who merely accumulate facts I can not very much respect."

The "Origin of Species" was at first intended to be published simply as an "Abstract," because the author regarded the use of some such term as the only possible apology for not giving references and facts in full, but the publisher objected to it, and the work appeared under the title it bears. There was a question whether it would be advisable to tell Mr. Murray that the book was "not more unorthodox than the subject makes inevitable"; or would it be better to say nothing to Mr. Murray, "and assume that he can not object to this much unorthodoxy, which, in fact, is not more than any geological treatise which runs slap counter to Genesis"?

Mr. Darwin had much difficulty with his style. While engaged upon his earlier works, he wrote: "I shall always feel respect for every one who has written a book, let it be what it may, for I had no idea of the trouble which trying to write common English could cost one," and, "It is an awful thing to say to one's self, 'Every fool and

every clever man in England, if he chooses, may make as many ill-natured remarks as he likes on this unfortunate sentence.'" Eight years later, "Writing plain English grows with me more and more difficult, and never attainable." While writing the "Origin of Species," although, he says, "No nigger with lash over him could have worked harder at clearness than I have done," he found the style incredibly bad, and most difficult to make clear and smooth. When informed by Lubbock of a blunder he had made in the principle of some calculation, which it would require two or three weeks of work to correct, he exclaimed, "I am the most miserable, bemuddled, stupid dog in all England, and am ready to cry with vexation at my blindness and presumption"; and, "If I am as muzzy on all subjects as I am on proportion and chance, what a book I shall produce!"

The question of priority, which arose between Mr. Darwin and Mr. Wallace—both having an announcement of the theory of natural selection ready to publish at the same time—was settled in a manner creditable to both gentlemen, and which adds luster to the scientific spirit. The letters show how far from rivalry were the feelings of both. Another question of priority arose after the "Origin" was published, when Mr. Patrick Matthew brought forth an extract from a work on "Naval Timber and Architecture," published in 1831, in which, says Mr. Darwin, "he briefly but completely anticipates the theory of natural selection. I have ordered the book, as some few passages are rather obscure, but it is certainly, I think, a complete but not developed anticipation! . . . Anyhow, one may be excused in not having discovered the fact in a work on naval timber." Mr. Darwin published an apology to Mr. Matthew for his entire ignorance of this publication; but the latter could not get over the feeling that another man had won the fame that he had missed. It afterward appeared that a Dr. Schaaffhausen had nearly anticipated his view in a pamphlet published at Bonn in 1853; and still later that Dr. Wells had applied "most distinctly" the principle of natural selection to the races of men in his "Essay on Dew," which was read to the Royal Society in 1813. A letter to Herbert Spencer, written in 1858, acknowledging the receptions of a volume of essays from him, is of interest as showing the relations of the work of these two laborers in adjoining fields. "Your remarks," says Mr. Darwin, "on the general argument of the so-called development theory seem to me admirable. I am at present preparing an abstract of a larger work on the changes of species; but I treat the subject simply as a naturalist, and not from a general point of view, otherwise, in my opinion, your argument could not have been improved on, and might have been quoted by me with great advantage." Of one of the numbers of Spencer's "Principles of Biology" Mr. Darwin observed: "I feel rather mean when I read him; I could bear, and rather enjoy feeling that he was twice as ingenious and clever as myself, but when I feel that he is about a dozen times my superior,

even in the master-art of wriggling, I feel aggrieved. If he had trained himself to observe more, even at the expense, by the law of balancement, of some loss of thinking power, he would have been a wonderful man." To E. Ray Lankester he acknowledged a suspicion that hereafter Spencer would be looked at as "by far the greatest living philosopher in England; perhaps equal to any that have lived."

A copy of the "Origin" was sent to Professor Agassiz, with the explanation that, "as the conclusions at which I have arrived on several points differ so widely from yours, I have thought (should you at any time read my volume) that you might think that I had sent it to you out of a spirit of defiance or bravado; but I assure you that I act under a wholly different frame of mind. I hope that you will at least give me credit, however erroneous you may think my conclusions, for having earnestly endeavored to arrive at the truth."

Mr. Darwin's relations with American men of science began with a letter to Asa Gray, in April, 1855, seeking for information on American Alpine plants, and offering an apology for the presumption of the writer, not a botanist, in making "even the most trifling suggestion to such a botanist as yourself." The correspondence was continued in frequent letters embodying discussions of subjects on which Mr. Darwin sought information or explanations from Professor Gray, the chief use of which was "to show a botanist what points a non-botanist is curious to learn; for I think every one who studies profoundly a subject often becomes unaware on what points the ignorant require information." After the publication of the "Origin," Mr. Darwin wrote to Professor Gray: "I should, for several reasons, be very glad of an American edition. I have made up my mind to be well abused; but I think it of importance that my notions should be read by intelligent men, accustomed to scientific argument, though not naturalists. It may seem absurd, but I think such men will drag after them those naturalists who have too firmly fixed in their heads that a species is an entity. . . . I should be infinitely obliged if you could aid an American edition." Professor Gray interested himself to secure a republication in the United States, and applied to a Boston house, while a New York house also moved in the matter. As he tells the story in a letter to Darwin: "All looked pretty well, when, lo! we found that a second New York publishing-house had announced a reprint also! I wrote then to both New York publishers, asking them to give way to the *author* and his reprint of a revised edition. I got an answer from the Harpers that they withdraw—from the Appletons that they had got the book *out* (and the next day I saw a copy); but that, 'if the work should have any considerable sale, we certainly shall be disposed to pay the author reasonably and liberally.' The Appletons being thus out with their reprint, the Boston house declined to go on. So I wrote to the Appletons, taking them at their word, offering to aid their reprint, to give them the use of the alterations in the London

reprint, as soon as I find out what they are, etc., etc." This was on the 23d of January, 1860. On the 22d of May of the same year, Mr. Darwin wrote acknowledging "a very pleasant remittance of £22" ($110), and adding, "If you have any further communication to the Appletons, pray express my acknowledgments for their generosity; for it is generosity, in my opinion." While Darwin and Gray were corresponding concerning the interests of the book and the reviews of it—favorable and adverse—in American periodicals, our civil war broke out; and we have, on the 5th of June, 1861, the expression:

"I never knew the newspapers so profoundly interesting. North America does not do England justice; I have not seen or heard of a soul who is not with the North. Some few, and I am one of them, even wish to God, though at the loss of millions of lives, that the North would proclaim a crusade against slavery. In the long run, a million horrid deaths would be amply repaid in the cause of humanity. What wonderful times we live in! Massachusetts seems to show noble enthusiasm. Great God! how I should like to see the greatest curse on earth—slavery—abolished!" In September Darwin said, "If abolition does follow with your victory, the whole world will look brighter in my eyes, and in many eyes."

Professor John Fiske, whose "Cosmic Philosophy," and Professor Morse, whose address on "What American Scientists have done for Evolution," he read with interest; and Professor Marsh, whose "Odontornithes" he regarded as having "afforded the best support to the theory of evolution which has appeared within the last twenty years," were other American scientific correspondents.

Mr. Darwin was not inclined to make public statements respecting his religious views, because he felt that a man's religion is an essentially private matter concerning himself alone, and because he thought that a man ought not to publish on a subject to which he had not given special and continuous thought.

In his twentieth year he had determined to become a clergyman, with full acceptance in his mind of the doctrines of the Church of England. While on the Beagle his faith in the literal interpretation of the Scriptures was regarded as something remarkable; but it was gradually surrendered in the face of his critical reflections, though very unwillingly, and disbelief creeping over his mind at a rate so slow as to give no distress, became at last complete. At a later period he was doubtful respecting the existence of a personal God; but, as he wrote in 1879, he was never an atheist in the sense of denying such existence, but considered that the term agnostic would be the more correct designation of his state of mind. He acknowledged to Miss Julia Wedgwood that the result of his reflections respecting design in Nature had been a maze, and that "where one would most expect design—viz., in the structure of a sentient being—the more I think on the subject, the less I see proof of design." He wrote to Mrs. Boole in 1866, "It has

always appeared to me more satisfactory to look at the immense amount of pain and suffering in this world as the inevitable result of the natural sequence of events—i. e., general laws—rather than from the direct intervention of God, though I am aware this is not logical with reference to an omniscient Deity."

He wrote to a Dutch student in 1873: "The impossibility of conceiving that this grand and wondrous universe, with our conscious selves, arose from chance, seems to me the chief argument for the existence of a God; but whether this is an argument of real value I have never been able to decide. . . . The safest conclusion seems to me that the whole subject is beyond the scope of man's intellect; but man can do his duty." In 1879 he wrote in the letter first made public by Haeckel: "Science has nothing to do with Christ, except in so far as the habit of scientific research makes a man cautious in admitting evidence. For myself, I do not believe that there ever has been any revelation. As for a future life, every man must judge for himself between conflicting vague probabilities." When the Duke of Argyll remarked to him in 1885, concerning some wonderful adaptations which he had described, that it was impossible to look at them without seeing that they are the effect and the expression of mind, he replied, "Well, that often comes over me with overwhelming force, but at other times it seems to go away."

One of the characteristics of Mr. Darwin's manner of working was his great respect for time. He used to say that saving the minutes was the way to get work done, and never allowed a few spare minutes to go to waste from thinking that it was not worth while to set to work. He would work up to the very limits of his strength and then suddenly stop, saying, "I believe I mustn't do any more." All his movements were performed as quickly as possible; but, in cases requiring care, he gave it. He saved a good deal of time through not having to do things twice—that is, by doing them right at first. His love of experiment was very strong, and was exemplified by his often saying, "I sha'n't be easy till I have tried it"; and he stuck unflinchingly to a subject on which he had once begun, for he could not bear to be beaten, and was accustomed to recall the phrase, "It's dogged as does it."

He was fond of light reading, and particularly enjoyed having novels read to him—provided they had good endings. He also liked a biography or a book of travels occasionally, but cared little for the old standards. In later life, he felt his taste for recreation fading out, and he regretfully wrote to Sir Joseph Hooker, in 1868, respecting the "Messiah": "It is the one thing that I should like to hear again, but I dare say I should find my soul too dried up to appreciate it as in old days; and then I should feel very flat, for it is a horrid bore to feel, as I constantly do, that I am a withered leaf for every subject except science. It sometimes makes me hate science, though God

knows I ought to be thankful for such a perennial interest, which makes me forget for some hours every day my accursed stomach." An extreme tenderness for suffering marked his whole life. But when the subject of vivisection came under discussion, he recognized the importance of experimental physiology. While insisting upon the imposition of close restrictions in operation, and the adoption of all possible measures to save pain to the objects of experiment, he approved of that method of study, for the sake of the wide and permanent relief from suffering that would accrue from the knowledge thereby gained.

THE INDIANS OF BRITISH COLUMBIA.

By Dr. FRANZ BOAS.

A PICTURE of the Indians whose life we intend to describe in the following pages does not bear the well-known features of the renowned hunters and daring warriors whom we are acquainted with from "Leather-Stocking" and other Indian stories. They are no noble figures roaming on horseback over the endless prairie; they are a quiet people of fishermen, whose appearance is so different from that of our Indians that at first sight one feels astonished and disappointed. They are of short stature, light complexion, with prominent cheeks, straight black hair, and sparkling black eyes. Their type reminds one so much of that of the races of Eastern Asia that in British Columbia they are generally considered the descendants of shipwrecked Japanese navigators.

The stranger who first visits Victoria, the capital of British Columbia, is struck by the great number of Indians who live in the city. They wear clothing of European style. The men work on the wharves and steamers, sell fish and skins, or are occupied in different trades, particularly as carpenters. The women wash and work for the whites, or stroll idly about the streets. The suburbs of Victoria are almost exclusively inhabited by the Indians. There they live in miserable, filthy shanties and sheds, or even in thin canvas tents. The city has about thirteen thousand inhabitants, and of these about two thousand are Indians who stay there over summer. Besides these, about three thousand Chinese, many Sandwich-Islanders, a few negroes, and a white population coming from all parts of Europe and America, live in the city. The internationality of the population and its easy-going ways give it a peculiar character.

But this is not the place to study the customs of the Indian. We must visit him in his village, where he lives undisturbed by the contact with Europeans, according to his ancient customs.

When the rainy season of fall approaches, most of the Indians who worked in Victoria over summer return to their villages, either in their

own canoes or on board of a small steamer plying between the city and the settlements all along the coast as far as the boundary of Alaska. When in the fall of 1886 I visited the Indian villages of that district to study the languages and customs of the natives, I joined a young Indian, who after a few years' absence was returning with his wife and children to his country. Soon the houses of Victoria disappeared from our view, and at the small miners' town of Nanaimo we had reached the terminus of European civilization. Dense woods, uninterrupted by fields or houses, cover the mountains and descend to the shore. No lighthouse warns the ship of the dangerous rocks and shoals which obstruct the narrow straits, and it seems almost incredible that it is only a few hours since we have left the busy town. The European population of the coast consists of a few traders, salmon-fishers, and missionaries, who lead a lonesome life among the Indians. Four days we had sailed through the narrow waters and approached the home of my Indian friend. He was unable to restrain his impatience any longer. By singing and dancing he expressed his joy at the return to his countrymen. At last the village appeared, which had been hidden from sight by a long island. It consisted of a row of well-built wooden houses, painted with gay figures, standing on a small opening. Canoes dug out of a single tree lay on the beach. As soon as the villagers heard the steam-whistle, they manned some boats and set out to meet the vessel. The luggage was thrown into the boats, and we sat down on top of it; the Indians paddled toward the land, while the steamer slowly disappeared from view. My friend had informed one of the chiefs of the village that I wished to stay with him. He came up to me in all his dignity and invited me to follow him into his house. Here I was at my leisure to look about among the people among whom I was so suddenly thrown.

The only garment of the natives consists of a cotton shirt, and a woolen blanket thrown over the shoulders like a toga; the women wear petticoats besides. Their hair is arranged in two braids, while the men tie a gay kerchief or a piece of skin round their heads to keep back the hair. Wondering, they surrounded the stranger, curious to know what might have induced him to visit their lonely village.

The house forms a square, the side of which is about fifty feet long. It is built of heavy planks which are tied to beams. The roof is also built of planks, and rests on a long timber which forms the ridge of the house. This timber rests on two pairs of uprights, one standing in the front and forming the door, the other one standing in the rear of the house. They are beautifully carved, and represent the crest of the house-owner. Around the walls an elevated platform, about four feet wide, is built, on which there are small sheds serving for bedrooms.

Each corner of the house is occupied by one family, their partition being divided from the rest by screens made of mats. An enormous

carved chair, large enough for a whole family, stands in each of these compartments facing a blazing wood-fire. The smoke fills the whole house, and escapes only slowly through a small opening in the roof and through the chinks of the planks.

The arrival of the stranger was an interesting topic of conversation, and groups of men and women were seen in eager discussion in our house and on the street which runs in front of the houses. My friend tried to explain to them that I did not intend to interfere with their feasts and usages, and that I did not want anything but to stay some time in their village and to trade with them. His endeavors, however, were unsuccessful, and the chief deemed it necessary to arrange a general council in which the presence of the stranger was to be discussed. In the evening I was told that on the next day a great feast was to be held and that my presence was requested. Of course I felt highly honored and was glad to have so soon an occasion to observe the peculiar feasts and customs of the natives.

Early in the morning all families were astir. The young men went out in their canoes at daybreak and returned about nine o'clock with heavy logs in tow, which were drawn upon the beach, split, and carried into the house in which the feast was to be held. Here men and women were busily engaged in preparations. The compartments were torn down, the frames and screens being taken away. The house was swept, and wood for a large fire piled up in the center of the building. Dried halibut, which is kept in large boxes, and fish-oil, which is preserved in tubes made of dried kelp, were taken from the store-rooms and served in enormous carved wooden dishes which represent the crest animal of the host's family. When everything was prepared, the men assembled. Women are not permitted to partake in the feasts except the eldest daughters of chiefs—if the eldest child happens to be a girl. Their faces are painted red and black; they are wrapped up in their best blankets; their hair is carefully arranged and frequently covered with eagle-down. A few old men carry carved sticks, and all sit on mats which are spread at the foot of the platform which encircles the floor of the house. The host and a young man who was hired for the purpose looked after the fire. When all were assembled, one man took up the drum, a large box made of bent wood, which is painted with the host's crest, and began beating the time with his fist. The old men joined him with their dancing-sticks, the rest of the men clapping their hands. Then the singing-master, who instructs daily the old and young men, started the tune, and the chorus joined him after a few bars. When the text of the song is long, he calls out the text of every verse, while the time-beating goes on and the chorus repeats the words, singing. The first song was a war-song:

"Do not fight with daggers; kill your enemies with your arrows. Thus the chief said, and his heart was glad when he had killed his

enemy. He was as strong as two thunder-birds when he went into the battle."

An ancient law demands that four songs be sung before the meal can be served and the debate can be opened. The young man dished out the meal, and while all were eating one of the chiefs rose, wrapped his blanket around him so as to leave one arm free, and began his speech. Of course, I did not understand him, but I saw from his expressive gestures that he spoke of me. After his long speech was finished, an interpreter was sent to me and translated the contents of the speech into Chinook.

I have to remark here that the Canadian Government tries to suppress the feasts of the natives, and that the Indian agent had occasionally threatened this tribe to send a man-of-war if they would not stop their feasts. As I was unknown to any of them, and even my friend had made my acquaintance only very recently, I was suspected to have come there in order to report to the Government, and to send a man-of-war. Therefore the chief spoke thus:

"We want to know whether you have come to stop our dances and feasts, as the missionaries and agents who live among our neighbors try to do. We do not want to have anybody here who will interfere with our customs. The agent has told us that he would send a man-of-war if we should continue to do as our grandfathers and great-grandfathers have done. But we do not mind his words. Is this the white man's land? The agent says this is the Queen's land; but no! it is mine. Where was the Queen when God sent down Qanikila?* Where was the Queen when Qanikila gave this land to my great-grandfather and told him, 'This will be thine'? My father owned this land and was a mighty chief; now it is mine. And when your man-of-war comes, let him destroy our houses. Do you see those woods? Do you see those trees? We shall cut them down and build new houses, and live as our fathers did. We will dance when our laws command us to dance, we will feast when our hearts desire to feast. Do we ask the white man, 'Do as the Indian does'? No, we do not. Why, then, will you ask us, 'Do as the white man does'? It is a strict law that bids us to dance. It is a strict law that bids us to distribute our property among our friends and neighbors. It is a good law. Let the white man observe his law; we shall observe ours. And now, if you are come to forbid us to dance, begone; if not, you will be welcome to us."

I was expected to answer this speech, and did so through the interpreter. I assured them of my friendly intentions, and said that I would not send a man-of-war—well I might promise that!—that I had no intention to interfere with their ways and customs; and, in order to show that I was their friend, I invited the whole tribe to a feast on the next night.

* Qanikila is the son of the deity in the traditions of this people.

The effect of this speech was very great. It seemed that all of a sudden the former distrust had vanished. Every one was eager to assure me that the Indians' hearts were glad when they heard my words, and that they hoped to see me long in their village. Soon after this the feast was at an end; the men carried the rest of their meals home to their wives and children, who returned the empty dishes the same night; and now every house was still and quiet, the inhabitants having gone to sleep.

The next morning they took up their regular occupations. Firewood was carried into the houses and the fires were lighted. Men and women got water from the near brook, and were busy washing their blankets and petticoats; the old men sat lazily on the wood platforms which are erected on the sea-side of the street, and looked at the fishermen who were out at sea in their canoes, talked over the events of the day, or passed the time in gambling. The platform is the favorite place of the Indian. There he sits for hours and hours, wrapped up in his blanket, and leaning on the heavy board which forms its balustrade. Clumsy steps cut out of large trees lead from the street and the platforms down to the beach, where fish are drying, where heavy logs of drift-wood are piled up for fire-wood, and where large cedars, which have been cut down with great difficulty and towed to the village, are burned out and dug out to become in the hands of the skillful native a swift and strong boat. Children are playing on the beach. They paddle about in small canoes and practice all kinds of sport.

About noon the hunters had returned, and the natives prepared for the feast which was to take place in the evening. They were determined to celebrate it by a great dance. In the flattering way which is characteristic of these tribes, one of the chiefs said to me: "When a great chief comes here, we do not always honor him by a dance, but as you are good and a mighty chief, and as you come from a far-away country, we wish to make your heart glad. Go into your house and await us!" The house in which I lived was prepared in the same way as described before, and I hired a young man to cook the meal for the sixty men whom I was expecting. When the meal was ready, the dancers had finished their preparations. The wife of my host took her place near the fire, and kept fish-oil ready for pouring it into the fire, which then blazes up and lightens the whole house. Now the dancers had assembled at the opposite end of the village. With sticks and fists they beat the time on the walls of the houses, and slowly approached, singing the dancing-song. Now the door of the house was torn open and the dancers appeared, one of the chiefs—a man of over sixty years—first. He was clothed in an old uniform and carried the British flag. The next day I learned that he had received both from the Superintendent of the Indians of British Columbia, with an appointment as sheriff, and the particular instruction to watch that no dances were held! How well he performed this duty was seen on

the evening when he came into our house, the chief dancer, flourishing the flag and dancing in grotesque movements. The walls of the house shook under the heavy fists and sticks of the dancers who beat the time outside and now entered one by one. The two dancers next to enter had each a blanket tied round his loins, the upper part of the body being naked. A carved wooden snake with two heads—the fabulous Sisiutl—was tied to the waist, and about their necks they wore rings of hemlock-branches. In the right hand they carried two sticks ornamented with gay ribbons; in the left they flourished bows and arrows. Their faces were painted black, and their hair was kept back by a tie of seal-skins with a bunch of red feathers attached to it. These were followed by two men wrapped up in white blankets and wearing stuffed mink-skins as head-dresses. The next dancer carried a rattle in his hands, which he hid under his dancing-apron. Then the rest of the dancers rushed into the room and formed a wide circle around the two men carrying the snake-carvings. Now began a wild song in which the chorus occasionally joined. As soon as the chorus fell in, the minks and the man carrying the rattle rushed into the center of the circle and jumped about in the wildest fashion. The women and children who stood by became greatly excited, and it looked very droll to see the little ones, who could hardly stand on their legs, dancing and imitating the motions of the performers. After the first round was finished, a new cry was heard outside, the door opened, and in came twelve boys, all naked, their little bodies whitened with lime, and all kinds of figures painted on them in red and black. Their hair was rubbed with a mixture of oil and lime, and looked like the bristles of a brush. The leader of the boys was an elderly man, who remained standing in the entrance of the house with uplifted hands, and directing the boys by rhythmical motions of his arms and his body. The figures of these dances were really artistic and symmetrical. At the end of the performance all left the house in grand procession and made a terrible noise before the entrance of every house of the village. If the owner's wife made the fire blaze up by pouring oil into it, this was an invitation for them to come in and perform a short dance. Where all remained dim and dark they passed by.

This dance had been invented when the daughter of the chief of a neighboring tribe married the young chief of this village. When the approach of the bride was announced, the men connected three boats by heavy planks, thus forming an extensive platform. They went on this raft to meet the strangers and welcomed them dancing this dance on the water. The boats of the young woman were loaded with her dower: boxes filled with blankets, valuable copper plates, and the *gyiserstal*—the latter being a heavy board, cut so as to represent a human jaw-bone. The front is set with sea-otter teeth. This object is given to the bridegroom, who thus obtains the right to command his wife to talk or to be silent.

The marriage ceremonies of these tribes are very complicated. The young man must buy his bride from his future father-in-law before he gets his consent to marry her. But even then the formalities he has to go through are not at an end. He must come into the house where the girl lives and sit down next to the door. Then the girl's parents know what he comes for. They scold him and abuse him as much as they can for two days. On the third day the mother gives him a mat to sit on, and on the fourth he gets a little food. Then he is invited to the fire, and the parents give their consent to the marriage. The chief of the gens to which the young man belongs now comes in great state and brings the price, which was agreed upon beforehand, to the parents, who in their turn on the next day pay a certain price, through the chief of their gens, to the parents of the young man. Then both parties give a great feast. At last the friends of the young man go to fetch the bride. They cover the road leading from their house to the beach with gay mats and embark in their boats. After a few hours they land before the house of the girl, though it may stand close to theirs, and lay mats from the beach to the house-door. Then the chief of the girl's gens dresses himself up with all his dancing-ornaments, takes her by the hand, and leads her to the boat, where she is received by the chief of the bridegroom's gens. Then they return to their house, and the marriage ceremonies are at an end.

The efforts of the missionaries to Christianize these Indians have in most places been very unsuccessful. The history of the mission is quite interesting, and has been the subject of some publications in our journals and newspapers. But, as in all these only one side of the Indian question in British Columbia has been presented, a few remarks on the state of affairs, which is not without influence upon our Alaska Indians, may not be out of place.

The first to take up the work energetically was Mr. Duncan, who established himself at Fort Simpson among the Tsimpshian tribe. His influence upon the Indians has been enormous.

These results have been brought about by the peculiar method Mr. Duncan applied in Christianizing these Indians. He did not deem it unworthy to trade for his pupils, and to teach them to *work*, instead of instructing them in the Christian faith alone. Thus he improved their condition, and was remarkably successful. In order to protect his adherents from the influence of the heathenish Indians and of the worse influences of the white traders, he emigrated with them from Fort Simpson and founded the settlement of Mestlakahtla, or more properly Meghtlaqatla (*gh* being pronounced like the German *ch*, and *g* being a very guttural *k*). He succeeded in keeping the destructive whisky-trade from his followers.

His success encouraged the missionaries of other churches. The Catholic Church had tried to convert and civilize the tribes on both

coasts of Vancouver Island and the mainland opposite. After a long series of years, they abandoned the task among the so-called Kwakiutl tribes in despair. Their success among the tribes on the mainland opposite Victoria was far greater, and on the west coast of Vancouver Island they are making rapid progress at the present time.

When the Catholic Church left the Kwakiutl tribes, the Church of England took up the work, but with little or no success; while near Victoria they and the Methodists were successful. From experience derived from a life with the Indians of all these tribes, it may safely be said that the only successful way of civilizing these tribes—and this refers to the Alaska tribes as well as to those of British Columbia—is to teach them to work. Then they will gradually abandon their fearful cannibal ceremonies and Shamanistic dances.

The traditions of these natives make them very ready to accept the Christian faith, as their principal legend tells of the Son of God, who descended from heaven and traveled all over the world, doing miracles everywhere. But I must state here that even the sincerest Christians among the Indians, who observe Sunday and preach in their churches, are not thoroughly civilized; that is, their way of thinking is not ours, but still under the influence of their ancient customs. The best proof of this is the fact that any one returning to a heathenish tribe will again adopt their mode of life, a very few perhaps excepted. This is not meant as a reproach to the missionaries or Indians. It is founded in psychologic laws, and we only consider it a mistake to believe that an acculturation to our civilized ways is a thorough civilization. This is true in regard to Duncan's Indians and all others.

Though remarkable progress has been made and the condition of many tribes has greatly improved, a general dissatisfaction exists among the Indians of British Columbia, which led to disturbances among those of Metlakahtla. There are two reasons for this state of affairs, which is of some importance, considering that 38,500 Indians live in British Columbia. During the last few years, reservations were allotted to each tribe and the rest of the land declared government land. Now, the Indians of the coast are not migratory, but claim to be autochthonous in their several districts. All tribes, from Puget Sound to Alaska, believe that the Son of God gave every gens a piece of land which they consider their personal property. In confining the tribes to reservations, the single man feels that his property has been taken from him without equivalent compensation. Treaties have not been made according to these facts with every gens, as these ethnological facts are unknown to many of the officers, and therefore the Indians feel as though they were treated unjustly.

The second reason for the discontent among the Indians is a law that was passed, some time ago, forbidding the celebrations of festivals. The so-called *potlatch* of all these tribes hinders the single fami-

lies from accumulating wealth. It is the great desire of every chief and even of every man to collect a large amount of property, and then to give a great *potlatch*, a feast in which all is distributed among his friends, and, if possible, among the neighboring tribes. These feasts are so closely connected with the religious ideas of the natives, and regulate their mode of life to such an extent, that the Christian tribes near Victoria have not given them up. Every present received at a *potlatch* has to be returned at another *potlatch*, and a man who would not give his feast in due time would be considered as not paying his debts. Therefore the law is not a good one, and can not be enforced without causing general discontent. Besides, the Government is unable to enforce it. The settlements are so numerous, and the Indian agencies so large, that there is nobody to prevent the Indians doing whatsoever they like.

The efforts of the Canadian Government to introduce agriculture are likewise not very successful. It is true that in some districts the extent of farming-land is considerable. But the Indian does not want to till the soil. The sea yields fish and seals; the woods furnish roots, berries, and deer; and the articles of European manufacture which he wants are either obtained by barter or by a few weeks of work in the canneries, saw-mills, hop-fields, or on ships. The industries to which the Indians of that region take readily are carpentry, canning salmon, etc.; and the introduction of proper methods of fishing and canning fish, of lumbering, and of trades connected with it, would be more probable to lead to satisfactory results than that of agriculture.

EVOLUTION: WHAT IT IS NOT, AND WHAT IT IS.

EVERYBODY nowadays talks about evolution. Like electricity, the cholera-germ, woman's rights, the great mining boom, and the Eastern question, it is "in the air." It pervades society everywhere with its subtile essence; it infects small talk with its familiar catchwords and its slang phrases; it even permeates that last stronghold of rampant Philistinism, the third leader in the penny papers. Everybody believes he knows all about it, and discusses it as glibly in his every-day conversation as he discusses the points of race-horses he has never seen, the charms of peeresses he has never spoken to, and the demerits of authors he has never read. Everybody is aware, in a dim and nebulous semi-conscious fashion, that it was all invented by the late Mr. Darwin, and reduced to a system by Mr. Herbert Spencer, don't you know, and a lot more of those scientific fellows. It is generally understood in the best-informed circles that evolutionism consists for the most part in a belief about Nature at large essentially similar to that applied by Topsy to her own origin and early history.

It is conceived, in short, that most things "growed." Especially is it known that, in the opinion of the evolutionists as a body, we are all of us ultimately descended from men with tails, who were the final offspring and improved edition of the common gorilla. That, very briefly put, is the popular conception of the various points in the great modern evolutionary programme.

It is scarcely necessary to inform the intelligent reader, who, of course, differs fundamentally from that inferior class of human beings known to all of us in our own minds as "other people," that almost every point in the catalogue thus briefly enumerated is a popular fallacy of the wildest description. Mr. Darwin did not invent evolution any more than George Stephenson invented the steam-engine, or Mr. Edison the electric telegraph. We are not descended from men with tails any more than we are descended from Indian elephants. There is no evidence that we have anything in particular more than the remotest fiftieth cousinship with our poor relation the West African gorilla. Science is not in search of a "missing link"; few links are anywhere missing, and those are for the most part wholly unimportant ones. If we found the imaginary link in question, he would not be a monkey, nor yet in any way a tailed man. And so forth generally through the whole list of popular beliefs and current fallacies as to the real meaning of evolutionary teaching. Whatever people think evolutionary is for the most part a pure parody of the evolutionist's opinion.

But a more serious error than all these pervades what we may call the drawing-room view of the evolutionist theory. So far as Society with a big initial is concerned, evolutionism first began to be talked about, and therefore known (for society does not read, it listens, or rather it overhears and catches fragmentary echoes), when Darwin published his "Origin of Species." That great book consisted simply of a theory as to the causes which led to the distinctions of kind between plants and animals. With evolution at large it had nothing to do; it took for granted the origin of sun, moon, and stars, planets and comets, the earth and all that in it is, the sea and the dry land, the mountains and the valleys, nay, even life itself in the crude form, everything, in fact, save the one point of the various types and species of living beings. Long before Darwin's book appeared, evolution had been a recognized force in the moving world of science and philosophy. Kant and Laplace had worked out the development of suns and earths from white-hot star-clouds. Lyell had worked out the evolution of the earth's surface to its present highly complex geographical condition. Lamarck had worked out the descent of plants and animals from a common ancestor by slow modification. Herbert Spencer had worked out the growth of mind from its simplest beginnings to its highest outcome in human thought.

But society, like Gallio, cared nothing for all these things. The

evolutionary principles had never been put into a single big book, asked for at Mudie's, and permitted to lie on the drawing-room table side by side with the last new novel and the last fat volume of scandalous court memoirs. Therefore society ignored them, and knew them not; the word evolution scarcely entered at all as yet into its polite and refined dinner-table vocabulary. It recognized only the "Darwinian theory," "natural selection," "the missing link," and the belief that men were merely monkeys who had lost their tails, presumably by sitting upon them. To the world at large, that learned Mr. Darwin had invented and patented the entire business, including descent with modification, if such notions ever occurred at all to the world-at-large's speculative intelligence.

Now, evolutionism is really a thing of far deeper growth and older antecedents than this easy, superficial, drawing-room view would lead us to imagine. It is a very ancient and respectable theory, indeed, and it has an immense variety of minor developments. I am not going to push it back, in the fashionable modern scientific manner, to the vague and indefinite hints in our old friend Lucretius. The great original Roman poet—the only original poet in the Latin language—did indeed hit out for himself a very good rough working sketch of a sort of nebulous and shapeless evolutionism. It was bold, it was consistent, for its time it was wonderful. But Lucretius's philosophy, like all the philosophies of the older world, was a mere speculative idea, a fancy picture of the development of things, not dependent upon observation of facts at all, but wholly evolved, like the German thinker's camel, out of its author's own pregnant inner consciousness. The Roman poet would no doubt have built an excellent superstructure if he had only possessed a little straw to make his bricks of. As it was, however, scientific brick-making being still in its infancy, he could only construct in a day a shadowy Aladdin's palace of pure fanciful Epicurean phantasms, an imaginary world of imaginary atoms, fortuitously concurring out of void chaos into an orderly universe, as though by miracle. It is not thus that systems arise which regenerate the thought of humanity; he who would build for all time must make sure first of a solid foundation, and then use sound bricks in place of the airy nothings of metaphysical speculation.

It was in the last century that the evolutionary idea really began to take form and shape in the separate conceptions of Kant, Laplace, Lamarck, and Erasmus Darwin. These were the true founders of our modern evolutionism. Charles Darwin and Herbert Spencer were the Joshuas who led the chosen people into the land which more than one venturous Moses had already dimly descried afar off from the Pisgah top of the eighteenth century.

Kant and Laplace came first in time, as astronomy comes first in logical order. Stars and suns, and planets and satellites, necessarily precede in development plants and animals. You can have no cabbages

without a world to grow them in. The science of the stars was therefore reduced to comparative system and order, while the sciences of life, and mind, and matter were still a hopeless and inextricable muddle. It was no wonder, then, that the evolution of the heavenly bodies should have been clearly apprehended and definitely formulated while the evolution of the earth's crust was still imperfectly understood, and the evolution of living beings was only tentatively and hypothetically hinted at in a timid whisper.

In the beginning, say the astronomical evolutionists, not only this world, but all the other worlds in the universe, existed potentially, as the poet justly remarks, in "a haze of fluid light," a vast nebula of enormous extent and almost inconceivable material thinness. The world arose out of a sort of primitive world-gruel. The matter of which it was composed was gas, of such an extraordinary and unimaginable gasiness that millions of cubic miles of it might easily be compressed into a common antibilious pill-box. The pill-box itself, in fact, is the net result of a prolonged secular condensation of myriads of such enormous cubes of this primeval matter. Slowly setting around common centers, however, in anticipation of Sir Isaac Newton's gravitative theories, the fluid haze gradually collected into suns and stars, whose light and heat are presumably due to the clashing together of their component atoms as they fall perpetually toward the central mass. Just as in a burning candle the impact of the oxygen atoms in the air against the carbon and hydrogen atoms in the melted and rarefied wax or tallow produces the light and heat of the flame, so in nebula or sun the impact of the various gravitating atoms one against the other produces the light and heat by whose aid we are enabled to see and know those distant bodies. The universe, according to this now fashionable nebular theory, began as a single vast ocean of matter of immense tenuity, spread all alike over all space as far as nowhere, and comparatively little different within itself when looked at side by side with its own final historical outcome. In Mr. Spencer's perspicuous phrase, evolution in this aspect is a change from the homogeneous to the heterogeneous, from the incoherent to the coherent, and from the indefinite to the definite condition. Difficult words at first to apprehend, no doubt, and therefore to many people, as to Mr. Matthew Arnold, very repellent, but full of meaning, lucidity, and suggestiveness, if only we once take the trouble fairly and squarely to understand them.

Every sun and every star thus formed is forever gathering in the hem of its outer robe upon itself, forever radiating off its light and heat into surrounding space, and forever growing denser and colder as it sets slowly toward its center of gravity. Our own sun and solar system may be taken as good typical working examples of how the stars thus constantly shrink into smaller and ever smaller dimensions around their own fixed center. Naturally, we know more about

our own solar system than about any other in our own universe, and it also possesses for us a greater practical and personal interest than any outside portion of the galaxy. Nobody can pretend to be profoundly immersed in the internal affairs of Sirius or of Alpha Centauri. A fiery revolution in the belt of Orion would affect us less than a passing finger-ache in a certain single terrestrial baby of our own household. Therefore I shall not apologize in any way for leaving the remainder of the sidereal universe to its unknown fate, and concentrating my attention mainly on the affairs of that solitary little, out-of-the-way second-rate system, whereof we form an inappreciable portion. The matter which now composes the sun and its attendant bodies (the satellites included) was once spread out, according to Laplace, to at least the farthest orbit of the outermost planet—that is to say, so far as our present knowledge goes, the planet Neptune. Of course, when it was expanded to that immense distance, it must have been very thin indeed, thinner than our clumsy human senses can even conceive of. An American would say, "too thin": but I put Americans out of court at once as mere irreverent scoffers. From the orbit of Neptune, or something outside it, the faint and cloud-like mass which bore within it Cæsar and his fortunes, not to mention the remainder of the earth and the solar system, began slowly to converge and gather itself in, growing denser and denser but smaller and smaller as it gradually neared its existing dimensions. How long a time it took to do it is for our present purpose relatively unimportant: the cruel physicists will only let us have a beggarly hundred million years or so for the process, while the grasping and extravagant evolutionary geologists beg with tears for at least double or even ten times that limited period. But at any rate it has taken a good long while, and, as far as most of us are personally concerned, the difference of one or two hundred millions, if it comes to that, is not really at all an appreciable one.

As it condensed and lessened toward its central core, revolving rapidly on its great axis, the solar mist left behind at irregular intervals concentric rings or belts of cloud-like matter, cast off from its equator; which belts, once more undergoing a similar evolution on their own account, have hardened round their private centers of gravity into Jupiter or Saturn, the Earth or Venus. Round these again, minor belts or rings have sometimes formed, as in Saturn's girdle of petty satellites; or subsidiary planets, thrown out into space, have circled round their own primaries, as the moon does around this sublunary world of ours. Meanwhile, the main central mass of all, retreating ever inward as it dropped behind it these occasional little reminders of its temporary stoppages, formed at last the sun itself, the main luminary of our entire system. Now, I won't deny that this primitive Kantian and Laplacian evolutionism, this nebular theory of such exquisite concinnity, here reduced to its sim-

plest terms and most elementary dimensions, has received many hard knocks from later astronomers, and has been a good deal bowled over, both on mathematical and astronomical grounds, by recent investigators of nebulæ and meteors. Observations on comets and on the sun's surface have lately shown that it contains in all likelihood a very considerable fanciful admixture. It isn't more than half true; and even the half now totters in places. Still, as a vehicle of popular exposition the crude nebular hypothesis in its rawest form serves a great deal better than the truth, so far as yet known, on the good old Greek principle of the half being often more than the whole. The great point which it impresses on the mind is the cardinal idea of the sun and planets, with their attendant satellites, not as turned out like manufactured articles, ready made, at measured intervals, in a vast and deliberate celestial orrery, but as due to the slow and gradual working of natural laws, in accordance with which each has assumed by force of circumstances its existing place, weight, orbit, and motion.

The grand conception of a gradual becoming, instead of a sudden making, which Kant and Laplace thus applied to the component bodies of the universe at large, was further applied by Lyell and his school to the outer crust of this one particular petty planet of ours. While the astronomers went in for the evolution of suns, stars, and worlds, Lyell and his geological brethren went in for the evolution of the earth's surface. As theirs was stellar, so his was mundane. If the world began by being a red-hot mass of planetary matter in a high state of internal excitement, boiling and dancing with the heat of its emotions, it gradually cooled down with age and experience, for growing old is growing cold, as every one of us in time, alas! discovers. As it passed from its fiery and volcanic youth to its staider and soberer middle age, a solid crust began to form in filmy fashion upon its cooling surface. The aqueous vapor that had floated at first as steam around its heated mass condensed with time into a wide ocean over the now hardened shell. Gradually this ocean shifted its bulk into two or three main bodies that sank into hollows of the viscid crust, the precursors of Atlantic, Pacific, and the Indian Seas. Wrinklings of the crust, produced by the cooling and consequent contraction, gave rise at first to baby mountain-ranges, and afterward to the earliest rough drafts of the still very vague and sketchy continents. The world grew daily more complex and more diverse; it progressed, in accordance with the Spencerian law, from the homogeneous to the heterogeneous, and so forth, as aforesaid, with delightful regularity.

At last, by long and graduated changes, seas and lands, peninsulas and islands, lakes and rivers, hills and mountains, were wrought out by internal or external energies on the crust thus generally fashioned. Evaporation from the oceans gave rise to clouds and rain and hail-storms; the water that fell upon the mountain-tops cut out the valleys and river-basins; rills gathered into brooks, brooks into streams,

streams into primeval Niles, and Amazons, and Mississippis. Volcanic forces uplifted here an Alpine chain, or depressed there a deep-sea hollow. Sediment washed from the hills and plains, or formed from countless skeletons of marine creatures, gathered on the sinking bed of the ocean as soft ooze, or crumbling sand, or thick mud, or gravel and conglomerate. Now upheaved into an elevated table-land, now slowly carved again by rain and rill into valley and water-shed, and now worn down once more into the mere degraded stump of a plateau, the crust underwent innumerable changes, but almost all of them exactly the same in kind, and mostly in degree, as those we still see at work imperceptibly in the world around us. Rain washing down the soil; weather crumbling the solid rock; waves dashing at the foot of the cliffs; rivers forming deltas at their barred mouths; shingle gathering on the low spits; floods sweeping before them the country-side; ice grinding ceaselessly at the mountain-top; peat filling up the shallow lake—these are the chief factors which have gone to make the physical world as we now actually know it. Land and sea, coast and contour, hill and valley, dale and gorge, earth-sculpture generally—all are due to the ceaseless interaction of these separately small and unnoticeable causes, aided or retarded by the slow effects of elevation or depression from the earth's shrinkage toward its own center. Geology, in short, has shown us that the world is what it is, not by virtue of a single sudden creative act, nor by virtue of successive terrible and recurrent cataclysms, but by virtue of the slow continuous action of causes still always equally operative.

Evolution in geology leads up naturally to evolution in the science of life. If the world itself grew, why not also the animals and plants that inhabit it? Already in the eager active eighteenth century this obvious idea had struck in the germ a large number of zoölogists and botanists, and in the hands of Lamarck and Erasmus Darwin it took form as a distinct and elaborate system of organic evolution. Buffon had been the first to hint at the truth; but Buffon was an eminently respectable nobleman in the dubious days of the tottering monarchy, and he did not care personally for the Bastile, viewed as a place of permanent residence. In Louis Quinze's France, indeed, as things then went, a man who offended the orthodoxy of the Sorbonne was prone to find himself shortly ensconced in free quarters, and kept there for the term of his natural existence without expense to his heirs or executors. So Buffon did not venture to say outright that he thought all animals and plants were descended one from the other with slight modifications; that would have been wicked, and the Sorbonne would have proved its wickedness to him in a most conclusive fashion by promptly getting him imprisoned or silenced. It is so easy to confute your opponent when you are a hundred strong and he is one weak unit! Buffon merely said, therefore, that if we didn't know the contrary to be the case by sure warrant, we might easily have concluded (so falli-

ble is our reason) that animals always varied slightly, and that such variations, indefinitely accumulated, would suffice to account for almost any amount of ultimate difference. A donkey might thus have grown into a horse, and a bird might have developed from a primitive lizard. Only we know it was quite otherwise! A quiet hint from Buffon was as good as a declaration from many less knowing or suggestive people. All over Europe, the wise took Buffon's hint for what he meant it; and the unwise blandly passed it by as a mere passing little foolish vagary of that great ironical writer and thinker.

Erasmus Darwin, the grandfather of his grandson, was no fool; on the contrary, he was the most far-sighted man of his day in England; he saw at once what Buffon was driving at; and he worked out "Mr. Buffon's" half-concealed hint to all its natural and legitimate conclusions. The great count was always plain Mr. Buffon to his English contemporary. Life, said Erasmus Darwin nearly a century since, began in very minute marine forms, which gradually acquired fresh powers and larger bodies, so as imperceptibly to transform themselves into different creatures. Man, he remarked, anticipating his descendant, takes rabbits or pigeons, and alters them almost to his own fancy, by immensely changing their shapes and colors. If man can make a pouter or a fantail out of the common sort, if he can produce a piebald lop-ear from the brown wild rabbit, if he can transform Dorkings into Black Spanish, why can not Nature, with longer time to work in, and endless lives to try with, produce all the varieties of vertebrate animals out of one single common ancestor? It was a bold idea of the Lichfield doctor—bold, at least, for the times he lived in—when Sam Johnson was held a mighty sage, and physical speculation was regarded askance as having in it a dangerous touch of the devil. But the Darwins were always a bold folk, and had the courage of their opinions more than most men. So even in Lichfield, cathedral city as it was, and in the politely somnolent eighteenth century, Erasmus Darwin ventured to point out the probability that quadrupeds, birds, reptiles, and men were all mere divergent descendants of a single similar original form, and even that "one and the same kind of living filament is and has been the cause of organic life."

The eighteenth century laughed, of course. It always laughed at all reformers. It said that Dr. Darwin was very clever, but really a most eccentric man. His "Temple of Nature," now, and his "Botanic Garden," were vastly fine and charming poems—those sweet lines, you know, about poor Eliza!—but his zoölogical theories were built of course upon a most absurd and uncertain foundation. In prose, no sensible person could ever take the doctor seriously. A freak of genius—nothing more; a mere desire to seem clever and singular. But what a Nemesis the whirligig of time has brought around with it! By a strange irony of fate, those admired verses are now almost entirely forgotten; poor Eliza has survived only as our awful example of arti-

ficial pathos; and the zoölogical heresies at which the eighteenth century shrugged its fat shoulders and dimpled the corners of its ample mouth, have grown to be the chief corner-stone of all accepted modern zoölogical science.

In the first year of the present century Lamarck followed Erasmus Darwin's lead with an open avowal that in his belief all animals and plants were really descended from one or a few common ancestors. He held that organisms were just as much the result of law, not of miraculous interposition, as suns and worlds and all the natural phenomena around us generally. He saw that what naturalists call a species differs from what naturalists call a variety merely in the way of being a little more distinctly marked, a little less like its nearest congeners elsewhere. He recognized the perfect gradation of forms by which in many cases one species after another merges into the next on either side of it. He observed the analogy between the modifications induced by man and the modifications induced by Nature. In fact, he was a thorough-going and convinced evolutionist, holding every salient opinion which society still believes to have been due to the works of Charles Darwin. In one point only, a minor point to outsiders, though a point of cardinal importance to the inner brotherhood of evolutionism, he did not anticipate his more famous successor. He thought organic evolution was wholly due to the direct action of surrounding circumstances, to the intercrossing of existing forms, and above all to the actual efforts of animals themselves. In other words, he had not discovered natural selection, the cardinal idea of Charles Darwin's epoch-making book. For him, the giraffe had acquired its long neck by constant reaching up to the boughs of trees; the monkey had acquired its opposable thumb by constant grasping at the neighboring branches; and the serpent had acquired its sinuous shape by constant wriggling through the grass of the meadows. Charles Darwin improved upon all that by his suggestive hint of survival of the fittest, and in so far, but in so far alone, he became the real father of modern biological evolutionism.

From the days of Lamarck to the day when Charles Darwin himself published his wonderful "Origin of Species," this idea that plants and animals might really have grown, instead of having been made all of a piece, kept brewing everywhere in the minds and brains of scientific thinkers. The notions which to the outside public were startlingly new when Darwin's book took the world by storm, were old indeed to the thinkers and workers who had long been familiar with the principle of descent with modification and the speculations of the Lichfield doctor or the Paris philosopher. Long before Darwin wrote his great work, Herbert Spencer had put forth in plain language every idea which the drawing-room biologists attributed to Darwin. The supporters of the development hypothesis, he said seven years earlier—yes, he called it the "development hypothesis" in so many

words—"can show that modification has effected and is effecting great changes in all organisms, subject to modifying influences." They can show, he goes on (if I may venture to condense so great a thinker), that any existing plant or animal, placed under new conditions, begins to undergo adaptive changes of form and structure; that in successive generations these changes continue, till the plant or animal acquires totally new habits; that in cultivated plants and domesticated animals changes of the sort habitually occur; that the differences thus caused, as, for example, in dogs, are often greater than those on which species in the wild state are founded, and that throughout all organic nature there *is* at work a modifying influence of the same sort as that which they believe to have caused the differences of species—"an influence which, to all appearance, would produce in the millions of years, and under the great variety of conditions which geological records imply, any amount of change." What is this but pure Darwinism, as the drawing-room philosopher still understands the word? And yet it was written seven years before Darwin published the "Origin of Species."

The fact is, one might draw up quite a long list of Darwinians before Darwin. Here are a few of them—Buffon, Lamarck, Goethe, Oken, Bates, Wallace, Lecoq, Von Baer, Robert Chambers, Matthew, and Herbert Spencer. Depend upon it, no one man ever yet of himself discovered anything. As well say that Luther made the German Reformation, that Leonardo made the Italian Renaissance, or that Robespierre made the French Revolution, as say that Charles Darwin, and Charles Darwin alone, made the evolutionary movement, even in the restricted field of life only. A thousand predecessors worked up toward him; a thousand contemporaries helped to diffuse and to confirm his various principles.

Charles Darwin added to the primitive evolutionary idea the special notion of natural selection. That is to say, he pointed out that, while plants and animals vary perpetually and very indefinitely, all the varieties so produced are not equally adapted to the circumstances of the species. If the variation is a bad one, it tends to die out, because every point of disadvantage tells against the individual in the struggle for life. If the variation is a good one, it tends to persist, because every point of advantage similarly tells in the individual's favor in that ceaseless and viewless battle. It was this addition to the evolutionary concept, fortified by Darwin's powerful advocacy of the general principle of descent with modification, that won over the whole world to the "Darwinian theory." Before Darwin, many men of science were evolutionists; after Darwin, all men of science became so at once, and the rest of the world is rapidly preparing to follow their leadership.

As applied to life, then, the evolutionary idea is briefly this—that plants and animals have all a natural origin from a single primitive living creature, which was itself the product of light and heat acting

on the special chemical constituents of an ancient ocean. Starting from that single early form, they have gone on developing ever since, from the homogeneous to the heterogeneous, assuming ever more varied shapes, till at last they have reached their present enormous variety of tree and shrub, and herb and sea-weed, of beast and bird, and fish and creeping insect. Evolution throughout has been one and continuous, from nebula to sun, from gas-cloud to planet, from early jelly-speck to man or elephant. So at least evolutionists say (?) and of course they ought to know most about it.

But evolution, according to the evolutionists, does not even stop there. Psychology as well as biology has also its evolutionary explanation: mind is concerned as truly as matter. If the bodies of animals are evolved, their minds must be evolved likewise. Herbert Spencer and his followers have been mainly instrumental in elucidating this aspect of the case. They have shown, or they have tried to show (for I don't want to dogmatize on the subject), how mind is gradually built up from the simplest raw elements of sense and feeling; how emotions and intellect slowly arise; how the action of the environment on the organism begets a nervous system of ever greater and greater complexity, culminating at last in the brain of a Newton, a Shakespeare, or a Mendelssohn. Step by step, nerves have built themselves up out of the soft tissues as channels of communication between part and part. Sense-organs of extreme simplicity have first been formed on the outside of the body, where it comes most into contact with external nature. Use and wont have fashioned them through long ages into organs of taste and smell and touch; pigment-spots, sensitive to light or shade, have grown by infinite gradations into the human eye or into the myriad facets of bee and beetle; tremulous nerve-ends, responsive sympathetically to waves of sound, have tuned themselves at last into a perfect gamut in the developed ear of men and mammals. Meanwhile corresponding percipient centers have grown up in the brain, so that the colored picture flashed by an external scene upon the eye is telegraphed from the sensitive mirror of the retina, through the many-stranded cable of the optic nerve, straight up to the appropriate headquarters in the thinking brain. Stage by stage the continuous process has gone on unceasingly, from the jelly-fish with its tiny black specks of eyes, through infinite steps of progression, induced by ever-widening intercourse with the outer world, to the final outcome in the senses and the emotions, the intellect and the will, of civilized man. Mind begins as a vague consciousness of touch or pressure on the part of some primitive, shapeless, soft creature; it ends as an organized and co-ordinated reflection of the entire physical and psychical universe on the part of a great cosmical philosopher.

Last of all, like diners-out at dessert, the evolutionists take to politics. Having shown us entirely to their own satisfaction the growth of suns, and systems, and worlds, and continents, and oceans, and

plants, and animals, and minds, they proceed to show us the exactly analogous and parallel growth of communities, and nations, and languages, and religions, and customs, and arts, and institutions, and literatures. Man, the evolving savage, as Tylor, Lubbock, and others have proved for us, slowly putting off his brute aspect derived from his early ape-like ancestors, learned by infinitesimal degrees the use of fire, the mode of manufacturing stone hatchets and flint arrow-heads, the earliest beginnings of the art of pottery. With drill or flint he became the Prometheus to his own small heap of sticks and dry leaves among the Tertiary forests. By his nightly camp-fire he beat out gradually his excited gesture-language and his oral speech. He tamed the dog, the horse, the cow, the camel. He taught himself to hew small clearings in the woodland, and to plant the banana, the yam, the bread-fruit, and the cocoanut. He picked and improved the seeds of his wild cereals till he made himself from grass-like grains his barley, his oats, his wheat, his Indian corn. In time, he dug out ore from mines, and learned the use first of gold, next of silver, then of copper, tin, bronze, and iron. Side by side with these long secular changes, he evolved the family, communal or patriarchal, polygamic or monogamous. He built the hut, the house, and the palace. He clothed or adorned himself first in skins and leaves and feathers; next in woven wool and fiber; last of all in purple and fine linen, and fared sumptuously every day. He gathered into hordes, tribes, and nations; he chose himself a king, gave himself laws, and built up great empires in Egypt, Assyria, China, and Peru. He raised him altars, Stonehenges and Karnaks. His picture-writing grew into hieroglyphs and cuneiforms, and finally emerged, by imperceptible steps, into alphabetic symbols, the raw material of the art of printing. His dug-out canoe culminates in the ironclad and the Great Eastern; his boomerang and sling-stone in the Woolwich infant; his boiling pipkin and his wheeled car in the locomotive-engine; his picture-message in the telephone and the Atlantic cable. Here, where the course of evolution has really been most marvelous, its steps have been all more distinctly historical; so that nobody now doubts the true descent of Italian, French, and Spanish from provincial Latin, or the successive growth of the trireme, the Great Harry, the Victory, and the Minotaur from the coracles or proas of prehistoric antiquity.

The grand conception of the uniform origin and development of all things, earthly or sidereal, thus summed up for us in the one word evolution, belongs by right neither to Charles Darwin nor to any other single thinker. It is the joint product of innumerable workers, all working up, though some of them unconsciously, toward a grand final unified philosophy of the cosmos. In astronomy, Kant, Laplace, and the Herschels; in geology, Hutton, Lyell, and the Geikies; in biology, Buffon, Lamarck, the Darwins, Huxley, and Spencer; in psychology, Spencer, Romanes, Sully, and Ribot; in sociology, Spencer,

Tylor, Lubbock, and De Mortillet—these have been the chief evolutionary teachers and discoverers. But the use of the word evolution itself, and the establishment of the general evolutionary theory as a system of philosophy applicable to the entire universe, we owe to one man alone—Herbert Spencer. Many other minds—from Galileo and Copernicus, from Kepler and Newton, from Linnæus and Tournefort, from D'Alembert and Diderot, nay, even, in a sense, from Aristotle and Lucretius—had been piling together the vast collection of raw material from which that great and stately superstructure was to be finally edified. But the architect who placed each block in its proper niche, who planned and designed the whole elevation, who planted the building firmly on the rock and poised the coping-stone on the topmost pinnacle, was the author of the "System of Synthetic Philosophy," and none other. It is a strange proof of how little people know about their own ideas, that, among the thousands who talk glibly every day of evolution, not ten per cent are probably aware that both word and conception are alike due to the commanding intelligence and vast generalizing power of Herbert Spencer.—*Cornhill Magazine.*

WEATHER-PROGNOSTICS.*

By the HON. RALPH ABERCROMBY.

FROM classic times, down to the commencement of this century, it can hardly be said that this branch of meteorology made any advance. Few, if any, new prognostics had been discovered, and neither their physical explanation nor their meteorological significance had been found out. But about eighty years ago some physical explanations were given. It was found that the air always contained a certain quantity of uncondensed vapor, and means were invented for measuring this amount accurately. From this, the nature and conditions of the formation of dew were discovered, and also that before many cases of rain the air became more charged with vapor. This latter fact gave the explanation of several rain-prognostics. For instance, when walls sweat, stones grow black, and clouds form on hill-tops, rain may be expected almost all the world over.

But even when these reasons had been discovered, the science flagged. A large number of rain-prognostics could not be shown by any means to depend on an increase of moisture, and, as vapor can not grow in the air, some explanation was needed to account for its variable quantity. And even when, in a general way, the prognostic had been explained, no clew whatever had been found for what we may

* Abridged from "Weather," by the Hon. Ralph Abercromby. "International Scientific Series," volume lviii. New York: D. Appleton & Co., 1888.

call the meteorological significance. What was the relation of the damp to the rain? Why did the prognostic sometimes fail? Why are there many rain-prognostics associated with a tolerably dry air? Why is not all rain preceded by the same set of prognostics? To all these questions no answer could be given. Prognostics had almost fallen into disrepute; they were considered no part of science, and had been supposed to be only suitable for rustics and sailors.

So the subject remained till the introduction of synoptic charts. Then it was soon seen that in temperate regions the broad features of weather depend on the shape of the isobaric lines, and later on it was shown—the author believes, mainly by himself—that nearly all prognostics have a definite place in some shape of isobars, and that all the above questions, formerly insoluble, receive a ready explanation. It has also been demonstrated that prognostics can never be superseded for use on board ship, and that even in the highest developments of weather-forecasting by means of electric telegraph, prognostics often afford most valuable information. But before we attempt to explain how this is done, we must introduce the reader into the elements of synoptic meteorology.

Synoptic meteorology is that part of the science which deals with the results obtained by constructing synoptic charts. Formerly, all meteorology was deduced from the changes which took place in the instrumental readings at any one place during any interval of time, say one day. For instance, a great deal had been discovered as to the connection between a falling or rising barometer and the accompanying rain or wind. Synoptic charts, on the contrary, are constructed by taking the readings of any instrument (say the barometer), or any observations on the sky or the weather (say where rain is falling, or cloud or blue sky is seen), at a large number of places at the same moment (say 8 A. M. at Greenwich). A map of the area or district from which the observations have been received is then taken, the barometer-readings are marked down over their respective places, and then lines are drawn through all the stations where the pressure is equal; for instance, through all the places where the pressure is 29·9 inches (760 mm.), and again at convenient intervals, generally of about two tenths of an inch, say 29·7 inches (755 mm.), 29·5 inches (750 mm.), and so on. These lines are called isobaric lines, or more shortly isobars—that is, lines of equal atmospheric weight or pressure. This method of showing the distribution of pressure by isobars is exactly analogous to that of marking out hills and valleys by means of contour-lines of equal altitude.

Similarly, the places which report rain, cloud, blue sky, etc., are marked with convenient symbols to denote these phenomena. Then arrows are placed over each observing station, with a number of barbs and feathers which roughly indicate the force of the wind. By an international convention, the arrows always fly with the wind;

that is to say, they do not face the wind like the pointer of a wind-vane.

When all this is done, we can see at a glance whether or how wind, rain, cloud, and blue sky are connected with the shape of the isobars. In fact, a synoptic chart gives us, as it were, a bird's-eye view of the weather at the particular moment for which the chart is constructed, over the whole district from which reports have been received. Suppose, now, that after an interval of twenty-four hours another chart is constructed from observations taken over the same area, then we generally find that the shape of the isobars and the position of the areas of high and low pressure have considerably changed, and with them the positions of those areas where the weather is good or bad. For instance, suppose that at 8 A. M. on one morning we find pressure low over Ireland and high over Denmark, with rain over Ireland, cloud over England, and blue sky in Denmark; and that by 8 A. M. on the following day we find that the low-pressure area has advanced to Denmark, and that a new high pressure has formed over Ireland, with rain in Denmark, broken sky in England, and blue sky in Ireland; suppose, too, that the record of the weather, say in London, for those twenty-four hours had been as follows—cloudy sky, followed by rain, after which the sky broke—how can an inspection of the two charts help us to explain the weather as observed in London during that day? Our bird's-eye view would show that the rain-area which lay over Ireland in the morning had drifted during the day over England, including London, and covered Denmark by next morning. It would also tell us that the position of the rain was identified with and moved along with the low pressure. This is the fundamental idea of all synoptic meteorology, but one which can only be thoroughly grasped after a considerable experience in tracing actual cases.

Such, then, is a synoptic chart. Many thousands have been constructed for all parts of the world, and by comparing them the following important generalizations have been arrived at:

1. That in general the configuration of the isobars takes one of seven well-defined forms.

2. That, independent of the shape of the isobars, the wind always takes a definite direction relative to the trend of these lines, and the position of the nearest area of low pressure.

3. That the velocity of the wind is always nearly proportional to the closeness of the isobars.

4. That the weather—that is to say, the kind of cloud, rain, fog, etc.—at any moment depends on the shape, and not the closeness, of the isobars, some shapes being associated with good and others with bad weather.

5. That the regions thus mapped out by the isobars were constantly shifting their position, so that changes of weather were caused by the drifting past of these areas of good or bad weather, just as on a small

scale rain falls as a squall drives by. The motion of these areas was found to follow certain laws, so that forecasting weather-changes in advance became a possibility.

6. That in the temperate zones sometimes, and habitually in the tropics, rain fell without any appreciable change in the isobars, though the wind conformed more regularly to the general law of these lines. This class of rainfall will be called "non-isobaric rain."

In Fig. 1 we give in a diagrammatic form the broad features only

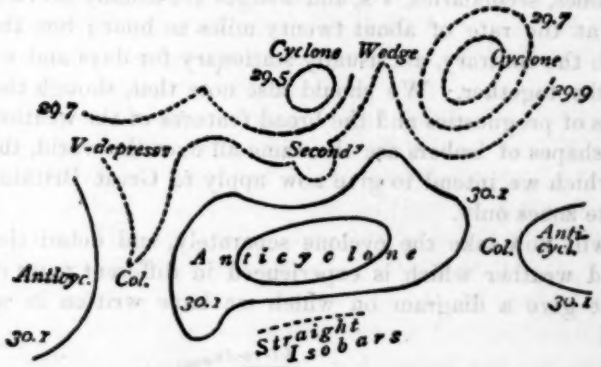


Fig. 1.—The Seven Fundamental Shapes of Isobars.

of the distribution of pressure over the North Atlantic, Europe, and the eastern portions of the United States on February 27, 1865. Coast-lines are omitted, so as not to confuse the eye, so also are lines of latitude and longitude; but the foot-note at the bottom of the figure represents the equator, and the top of the diagram would be on the Arctic Circle. All pressures of and under 29·9 inches (760 mm.) are shown with dotted lines, so that the eye sees at a glance the broad distribution of high or low pressure. The whole seven fundamental shapes of isobars will be found there.

Looking at the top of the diagram, we see two nearly circular areas of low pressure, round which the isobars are rather closely packed. Such areas, or rather the configurations of isobars which inclose them, are called "cyclones," from a Greek word meaning a circle, because they are nearly circular, and, as we shall see presently, the wind blows nearly in a circle round their center. Just south of one of the cyclones, the isobar of 29·9 inches (760 mm.) forms a small sort of nearly circular loop, inclosing lower pressure; this is called a "secondary cyclone," because it is usually secondary or subsidiary to the primary cyclones above described. Farther to the left the same isobar of 29·9 inches bends itself into the shape of the letter V, also inclosing low pressure; this is called a "V-shaped depression," or, shortly, a "V." Between the two cyclones the isobar of 29·9 inches projects upward, like a wedge or an inverted letter V, but this time incloses high pressure; this shape of lines is called a "wedge." Below all these we see an oblong area

of high pressure, round which the isobars are very far apart; this is called an "anticyclone," because it is the opposite to a cyclone in everything—wind, weather, pressure, etc. Between every two anticyclones we find a furrow, neck, or "col" of low pressure analogous to the *col* which forms a pass between two adjacent mountain-peaks. Lastly, as marked in the lower edge of the diagram, isobars sometimes run straight, so that they do not include any kind of area, but represent a barometric slope analogous to the sloping sides of a long hill. The cyclones, secondaries, V's, and wedges are usually moving toward the east at the rate of about twenty miles an hour; but the anticyclones, on the contrary, are usually stationary for days and sometimes for months together. We should also note that, though the general principles of prognostics and the broad features of the weather in each of these shapes of isobars are the same all over the world, the minute details which we intend to give now apply to Great Britain and the temperate zones only.

We will now take the cyclone separately, and detail the kind of wind and weather which is experienced in different parts of it. In Fig. 2 we give a diagram on which we have written in words the

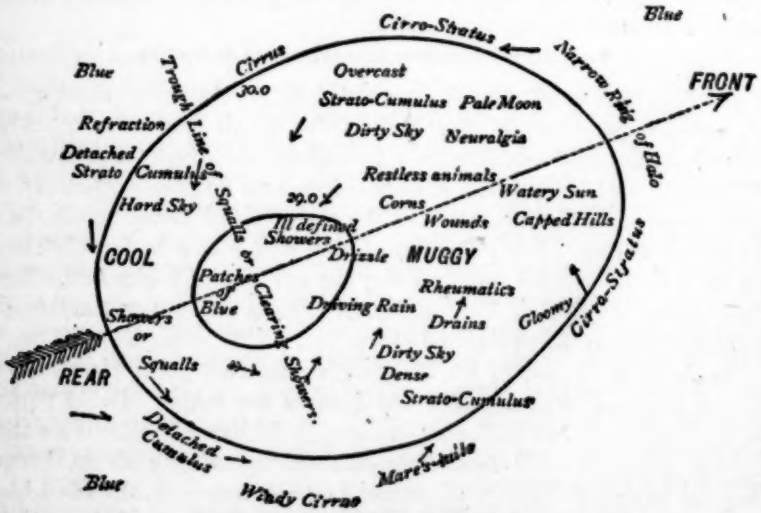


FIG. 2.—CYCLONE PROGNOSTICS.

kind of weather which would be found in every portion of a typical cyclone; arrows also show the direction of the wind relative to the isobars and to the center. First let us look at the isobars. We find that they are oval, and that they are not quite concentric, but the center of the inner one we will call the center of the cyclone. Now observe the numbers attached to the isobars; the outer one is 30·0 inches (762 mm.), the inner one 29·0 inches (737 mm.). But suppose the outer one was the same, but the inner one was 29·5 (755 mm.).

We should then have two cyclones, differing in nothing but depth; that is, in the closeness of the isobars, or the steepness of the barometric slope. Observation has shown that under these circumstances the general character of the weather and the direction of the wind everywhere would be the same; the only difference would be that the wind would blow a hard gale in the first and only a moderate breeze in the second case; and that what was a sharp squall in the one would be a quiet shower in the other. This is one of the fundamental principles of synoptic meteorology—that the character of the weather and direction of the wind depend entirely on the shape of the isobars, while the force of the wind and intensity of the character of the weather depend only on the closeness of the isobars.

The difference in the details of the weather in a cyclone, or any other isobaric shape which are due to difference in the steepness of the isobars, is called a difference in the intensity of the weather. Hence, when we speak of a cyclone as being intense, we mean that it has steep isobars somewhere. When we come to talk about the general sequence of weather from day to day, we shall find that *there is no difference between the cyclones which cause storms and those which cause ordinary weather except intensity.* This is another of the fundamental principles of meteorology.

Returning now to our cyclone, the whole of the portion in front of the center facing the direction toward which it moves is called its front, and the whole of this portion may obviously be divided into a right and left front. The other side of the center is, of course, the rear of the cyclone. Then, as the whole cyclone moves along its course, it is evident that the barometer will be falling more or less at every portion of the front, and rising more or less everywhere in the rear, so that there must be a line of places somewhere across the cyclone where the barometer has touched its lowest point and is just going to rise. This line is called the "trough" of the cyclone, because if we look at the barometer-trace at any one place, the "ups" and "downs" suggest the analogy of waves, so that the lowest part of a trace may be called a "trough." Or we may look at the cyclone as a circular eddy, moving in a given direction, and so far presenting some analogy to a wave.

So far for the shape and names of the different portions of the cyclone. Now for the wind. A glance at the arrows will show that, broadly speaking, the wind rotates round the center in a direction opposite to the motion of the hands of a watch. That is to say, that in the extreme front, following the outer isobar, the wind is from the southeast; farther round, it is from the east-northeast; still farther, from the north-northwest; then from about west; and, finally, from the southwest. Then we note that in front the wind is slightly incurved toward the center, and therefore blows somewhat across the isobars, while in rear it has little or no incurvature, and blows nearly

parallel to the isobars. The velocity or force of the wind will depend on the closeness of the isobars. In the diagram they are much closer set in rear than in front of the cyclone, and therefore the wind is strongest behind the center.

The weather in a cyclone is somewhat complicated. Some characteristic features depend on the position of the trough, and have nothing to do with the center. For instance, the weather and sky over the whole front of the cyclone—that is, all that lies in front of the trough—is characterized by a muggy, oppressive feel of the air, and a dirty, gloomy sky of a stratiform type, whether it is actually raining or only cloudy. On the other side, the whole of the rear is characterized by a sharp, brisk feel of the air, and a hard, firm sky of cumulus type.

But, on the contrary, other characteristic features are related to the center, and have little to do with the trough. The rotation of the wind, though slightly modified near the trough, is in the main related to the center, and the broad features of the weather in a cyclone are—a patch of rain near the center, a ring of cloud surrounding the rain, and blue sky outside the whole system. The center of the rain-area is rarely concentric with the isobars. It usually extends farther in front than in rear, and more to the south than to the north, but is still primarily related to the center.

This will be readily seen by reference to the diagram; there the drizzle and driving rain extend some distance to the right front, while almost directly behind the center patches of blue sky become visible. Thus a cyclone has, as it were, a double symmetry; that is to say, one set of phenomena, such as warmth, cloud character, etc., which are symmetrically disposed in front and rear of the trough; and another set, such as wind and rain, which are symmetrically arranged round the center. There is reason to believe that what we may call the circular symmetry of a cyclone is due to the rotation of the air, while the properties which are related to the trough are due to the forward motion of the whole system.

We have marked on the diagram the kind of weather and cloud which would be found in different parts of a cyclone. The first thing which will strike us is that the descriptive epithets applied to the sky contain the phraseology of the most familiar prognostics. At the extreme front we see marked "pale moon," "watery sun," which means that in that portion of a cyclone the moon or sun will look pale or watery through a peculiar kind of sky. But all over the world a pale moon and watery sun are known as prognostics of rain. Why are they so? The reason we can now explain. Since a cyclone is usually moving, after the front part where the sky gives a watery look to the sun has passed over the observer, the rainy portion will also have to come over him before he experiences the blue sky on the other side of the cyclone.

Suppose the cyclone stood still for a week, then the observer would see a watery sky for a week, without any rain following. Suppose the cyclone came on so far as to bring him under a watery sky, and then died out or moved in another direction, then, after seeing a watery sky, no rain would fall, but the sky would clear. The prognostic would then be said to fail, but the word is only partially applicable. The watery sky was formed and seen by the observer, because he was in the appropriate portion of the cyclone, and so far the prognostic told its story correctly—viz., that the observer was in the front of the rainy area of a cyclone. The prognostic failed in its ordinary indication because the cyclone did not move on as usual, but died out, and therefore never brought its rainy portion over the observer. This is the commonest source of the so-called failure of a rain-prognostic in Great Britain. The reason why all rain is not preceded by a watery sky is because there are other sources of rain besides a cyclone, which are preceded by a different set of weather-signs. Such is the whole theory of prognostics.

The same reasoning which applies to a watery sky holds good for every other cyclone-prognostic. We shall have explained why any prognostic portends rain when we have shown that the kind of sky or other appearance which forms the prognostic belongs to the front of the rainy portion of a cyclone. Conversely we shall have explained why any prognostic indicates finer weather when we have shown that the kind of sky belongs to the rear of a cyclone. It will be convenient, therefore, to describe the weather in different parts of a cyclone, and the appropriate prognostics together.

First, to take those prognostics which depend on qualities common to the whole front of the cyclone, viz., a falling barometer, increased warmth and damp, with a muggy, uncomfortable feel of the air, and a dirty sky.

From the increasing damp in this part of a cyclone, while the sky generally is pretty clear, cloud forms round and "caps" the tops of hills, which has given rise to numerous local sayings. The reason is that a hill always deflects the air upward. Usually the cold caused by ascension and consequent expansion is not sufficient to lower the temperature of the air below the dew-point; but when very damp, the same amount of cooling will bring the air below the dew-point, and so produce condensation.

From the same excessive damp the following may be explained: "When walls are more than usually damp, rain is expected." The Zuñi Indians in New Mexico say that "when the locks of the Navajos grow damp in the scalp-house, surely it will rain." From this we may assume that scalps are slightly hygroscopic, probably from the salt which they contain. Also, owing to excessive moisture, clouds appear soft and lowering, and reflect the glare of iron-works and the lights of large towns.

With the gloomy, close, and muggy weather, some people are troubled with rheumatic pains and neuralgia, old wounds and corns are painful, animals and birds are restless, and drains and ditches give out an offensive smell.

A glance at the diagram will show that the barometer falls during the whole of the front of the cyclone. Therefore the explanation of the universally known fact that the barometer generally falls for bad weather is, that both rain and wind are usually associated with the front of a cyclone. When we discuss secondaries, we shall find a kind of rain for which the barometer does not fall; and in our chapter on forecasting for solitary observers we shall explain why it sometimes rains while the barometer is rising, and why there is sometimes fine weather while the mercury is falling.

Now, to take prognostics which belong to different portions of the cyclone-front. By reference to Fig. 2 it will be seen that in the outskirts of the cyclone-front there is a narrow ring of halo-forming sky. Hence the sayings: "Halos predict a storm (rain and wind, or snow and wind) at no great distance, and the open side of the halo tells the quarter from which it may be expected." "Mock suns predict a more remote and less certain change of weather."

Inside the halo sky comes the denser cloud which gives the pale watery sun and moon. Still nearer the center we find rain, first in the form of drizzle, then as driving rain. In the left front we find ill-defined showers and a dirty sky.

We have now come to the trough of the cyclone. The line of the trough is often associated with a squall or heavy shower, commonly known as "a clearing shower." This is much more marked in the portion of the trough which lies to the south of the cyclone's center than on the northern side.

Then we enter the rear of the cyclone. The whole of the rear is characterized by a cool, dry air, with a brisk, exhilarating feel, and a bright sky, with hard cumulus cloud. These features are the exact converse of those we found in the cyclone-front. In the cloud-forms especially we see this difference. All over the front, whether high up or low down, whether as delicate cirrus or heavy gloom, the clouds are of a stratified type. Even under the rain, when we get a peep through a break in the clouds, we find them lying like a more or less thick sheet over the earth. All over the rear, on the contrary, clouds take the rocky form known as cumulus; cirrus is almost unknown in the rear of a cyclone-center in the temperate zone.

In the exhilarating quality of the air we find the meaning of the proverb, "Do business with men when the wind is in the northwest." A northwest wind belongs to the rear of a cyclone, and improves men's tempers, as opposed to the neuralgic and rheumatic sensations in front of a cyclone, which make them cross.

As to the details of the different portions of the rear. Immediately

behind the center small patches of blue sky appear. Farther from the center we find showers or cold squalls; beyond them, hard detached cumulus or strato-cumulus; still farther the sky is blue again. In the south of the cyclone, near the outskirts, the long, wispy clouds known as windy cirrus and "mares' tails" are observed. These indicate wind rather than rain, as they are outside of the rainy portion of the cyclone.

THE ANTECHAMBER OF CONSCIOUSNESS.

By FRANCIS SPEIR, Jr.

I.

THACKERAY, in that delightful "Roundabout Paper," "De Finibus," confidentially discusses with the reader the genesis of his literary creations. In introducing the subject of this article I shall quote this passage as presenting a pleasing exposition of a certain phase of literary work that is accomplished apparently without any action of the will to account for the result: "I have been surprised at the observations made by some of my characters. It seems as if an occult power was moving the pen. The personage does or says something, and I ask, 'How the dickens did he come to think of that?' Every man has observed in dreams the vast dramatic power that is evinced—I won't say the surprising power, for nothing does surprise you in dreams—but those strange characters you meet make instant observations, of which you never can have thought previously. In like manner the imagination foretells things; we spake anon of the afflated style, when a writer is like a pythoness on her oracle tripod, and mighty words—words which he can not help—come blowing, and whistling, and moaning through the speaking-tubes of his bodily organ." Our literature is full of suggestions such as this, pointing to an intellectual workhouse where all is unknown, but from which comes forth polished, finished work, done how or where we know not.

My attention for some years has been directed to the subject of unconscious cerebration, as it is called, and to the literature of the subject, from the suggestion of its existence by Leibnitz, to its present exposition by Carpenter, Holmes, and Miss Cobbe. It was with a desire to throw the light of further-collected facts upon the relation of a conscious activity to a possible unconscious cerebral activity that I undertook the task of collecting the necessary data. The method employed in collecting these data was the well-known one of the distribution of printed questions to be answered from personal experience. While much of the ground has been gone over before, the questions at issue have been tested largely upon hearsay evidence—tales that somebody has told of somebody else; hence, with our human infirmities, the generalization founded on such facts can fairly be questioned.

From a distribution of over six hundred copies of a set of questions upon this subject, I have received one hundred and two answers, largely from professional men and women, and from the students of the upper classes of our leading American colleges, each paper subscribed with the name, age, and address of the sender. In obtaining this mass of material, I have been placed under great obligations to President McCosh; to Professor George P. Fisher, of Yale College; Professor William James, of Harvard College; President Robinson, of Brown; Professor Osborn, of Princeton; Professor Stanley Hall, of Johns Hopkins; Dr. Nicholas Murray Butler, of Columbia; and Professor Torrey, of the University of Vermont. The healthy, normal side of this subject is the only one I shall attempt to consider, leaving the questions of morbid pathology to those who alone can weigh the evidence it throws upon the subject.

If, in our experience, we witness an effect, we know, by the inexorable logic of science, that its existence must be due to some efficient cause. "Verily a tree is known by its fruit" is sound teaching and sound sense—it is axiomatic. If a solution of a mathematical problem can really be revealed to us in consciousness, while we are busied about other things, it must inevitably have been performed by means of the processes which regularly lead to such a result, even if we are not conscious at the time of employing such processes. It could not have come spontaneously, but only as the result. As a consequence, in such a case we would be bound to predicate some exercise of intellectual powers, actively working during unconsciousness. The circular before referred to comprised eleven questions; those, the results of which are specially used here, are as follow:

Second Question.—"1. When you are unable to recall the name of something wanted, and you say, 'Never mind, it will occur to me,' are you conscious of any effort at searching after it?

"2. When you are, do you feel some trouble or weight in your effort?

"3. When you are not, does the idea ever, when it occurs, seem to have come back spontaneously, without being suggested by any perceived association of ideas?"

Third Question.—"During sleep, have you ever pursued a logical, connected train of thought upon some topic or problem in which you have reached some conclusion, and the steps and conclusions of which you have remembered on awakening?"

Sixth Question.—"1. Can you wake precisely at a given hour, determined upon before going to sleep, without waking up many times before the appointed time?

"2. If you can, then (*a*) is this habitual, or do you often fail? (*b*) Are you conscious, before waking, of any feeling? (describe it), or (*c*) do you come directly from oblivion into consciousness?"

Ninth Question.—"When perplexed at your progress in any work (mathematical, professional, literary, chess, puzzles, etc.), have you ever left it unfinished and turned your attention to other things, and, after some time, on voluntarily returning to it, have found yourself able at once to satisfactorily master it?"

TENTH QUESTION.—"1. Have you ever been conscious of having involuntarily discovered something new—e. g., an invention, a literary or poetical creation, a mathematical solution, etc.?

"2. If yes, then has this flashed into consciousness in the form of a clear conception?"

II.

In order to set forth logically the results of the answers received, I shall group them according to the following analysis: Does there exist in man the power to exert intellectual activity during unconsciousness in these several forms?

First. When the effort is simple by reproducing past experiences in obedience to a mandate of will.

Second. By comparing related facts and arriving at a settled judgment.

Third. When the effort is more complex by continuing old trains of thought begun in consciousness and proceeding logically, step by step, to a rational settled conclusion.

Fourth. When the effort is most complex, by commencing and continuing new trains of thought without having voluntarily undertaken or continued them, and arriving at results of original creation as inventions, literary and musical creations, etc.

First. The first division of the subject is restricted to the antechamber of consciousness; it contains the inquiry as to the possibility of working for a lost idea, fact or fancy, while consciously devoting one's whole attention to something else. This established, it must follow that during the unconscious interval which intervenes between the desire for the lost object and its occurrence in consciousness, an intellectual activity was at work similar in all respects to the conscious activity, minus the element of self-looking, at self-working. Some of the instances given in the answers, worthy of being cited as illustrations, are as follow:

1. Miss H——, of Princeton, writes: "Yesterday I tried at breakfast to recollect the name of Azimolate Khan, but could only remember that it began with 'Az.' I felt vexed for a moment only, and totally forgot it, being absorbed in an interesting subject. In about ten minutes I said aloud, 'It is Azimolate Khan!' and was scarcely conscious that I had said it, it came so suddenly to me."

2. Mr. V——, of Brooklyn, New York city, writes: "While writing a paper on a medical subject I had occasion to use the technical term for a swoon, which I could not recall. At this point, being obliged to attend a lecture, spontaneously and apparently without reason—for the two subjects had no connection—the word 'syncope' shot across my mind; immediately after, the medical paper came into my mind."

3. Mr. L——, of New York, writes: "One case I remember. I was trying to think of the name of a book and gave it up. About half an hour after I was talking of something else, when all of a sudden I

blurted out the name without any conscious volition on my part, or without thinking anything about the book at all."

4. The writer, being asked who was the author of the pamphlet entitled "Taxation no Tyranny," although knowing well, was unable to answer. Two days afterward, while working at a law brief, suddenly said aloud, "Dr. Johnson wrote 'Taxation no Tyranny.'" He took pains to examine the writing before him and the chain of reasoning engaged in at the time, but could not find the slightest suggestion of the answer. He had apparently forgotten entirely about the question asked him for at least forty-eight hours prior to answering it, and had experienced no trouble or weight of mind in the interval.

5. Mr. B——, of New York city, writes: "Only recently, being asked a lady's name, I found myself only able to recall the surname. I said, 'I will think of the other—wait a moment.' Walking along the street a few minutes later, I heard one small boy say to another, 'You lie like ——!' Instantly, I was conscious that something in that phrase bore upon something else that I had been thinking about, but what it was I could not tell. An hour or so later, when occupied in writing, it flashed upon me that the name of the lady that I was searching for was 'Lila,' and instantaneously the relevancy of the phrase overheard in the street came to me; it was the resemblance in sound, 'Lila,' to 'lie like.'"

Under this head the statistical result may be summed up thus: Ninety-five persons answered this particular inquiry. Of these, ninety-one per cent state that they have had similar experiences, three per cent have not. With forty per cent there was often an oppressive feeling of trouble or anxiety experienced just before the solution had come, and not then attributable to anything in particular; but after the answer had come, twenty per cent almost instinctively attributed this oppression to the fatigue of mental effort involved in finding the answer. With sixty per cent no oppression was noted; about thirty per cent noticed that the answers frequently came after comparative rest or sleep, and seventy per cent have not noticed the time of the recovery. Almost every individual says concerning these experiences, "They are of such frequent occurrence that when they happen I pay no special attention to them."

Second. If, while unconscious, it is possible to attain the result that can only come from reckoning—a judgment founded on the comparative relations of a unit—this must be the result of an intellectual activity which exists unknown to the conscious self, and entirely escapes all notice from the moderately keen eye of self-consciousness. Most people can approximately tell what hour of the day it is without consulting a timepiece, and, the less they are in the habit of depending upon such a luxury, the more accurate their computation is likely to be. This computation is founded on a calculation of the comparative value of the time between two known points translated into the arbi-

trary measure of hours and minutes. A calculation is performed, however quickly or unconsciously. The question of being able to wake from a sound sleep at an unusual time, in obedience to an act of will registered before going to sleep, brings this phenomenon with this subdivision. The answers to the question in this connection are as follow :

1. Mr. L——, of Philadelphia, writes : "I can wake within a few minutes of a given time without effort. Habitually I wake within a few minutes of a fixed time. I can, however, wake without effort at a different time."

2. Miss B——, of New York city : "Yes, at an early or unusual hour, by repeating the time to myself once or twice before going to sleep. I seldom wake before the hour determined upon, and never fail to wake then. I come directly into full consciousness at all times."

3. Mr. A——, of Omaha, Nebraska : "Yes, within three minutes."

4. Mrs. Y——, of Paterson, New Jersey : "Can awaken at a given hour determined upon without waking before at all. Have not found it necessary to do so often, but have never failed in the attempt. Come directly from oblivion into consciousness."

5. Mr. C——, of Orange, New Jersey : "Have never overslept when my mind has been charged before retiring."

6. Mr. B——, of Paterson, New Jersey : "I was intrusted by the attending physician with the administering of medicines to my wife, who was very dangerously ill. It was of the greatest importance that a certain medicine should be given every two hours as exactly as possible, day and night. I am an extraordinarily sound sleeper ; but, for six weeks, I woke up every two hours methodically, and never missed giving the medicines once during that time. I always came directly from oblivion into consciousness. During the first few nights I was as exact and methodical as in the last."

The statistical result is as follows : Forty per cent claim to have this power in a strongly marked degree ; they can wake up at an unusual hour without having their rest at all disturbed prior to their awaking. Of this forty per cent, about fifty per cent say that they are conscious of being troubled just before the real light of consciousness has risen ; the other fifty per cent say that they only know that at the predetermined time they are awake. The sixty per cent who do not possess this power in a marked degree are about evenly divided, one half spending their night continually disturbed by false alarms, and the other fifty per cent sleep peacefully on with rest unbroken, either at, before, or after the appointed hour for awaking. I find that I overlooked one important point in this inquiry, namely, whether those who can wake up at almost the minute of the given hour possess a similarly accurate power of measuring time in consciousness.

To sum up the conclusions on this point : Many people during a state of perfect unconsciousness can accurately measure time as well

as and often better than they can in consciousness, when they largely rely upon an artificial time-computer. In doing this they may perform an intellectual process similar in all respects to the conscious act of calculating a distance between known points.

Third. This division covers a wide field of intellectual activity, and the inquiry is here directed to the result of systematically connected thought, omitting only original research which is considered later. Is there unconscious reasoning of a complex kind employed when old work begun in consciousness is carried on or brought to a logical conclusion unknown to the thinker, as in the cases of solving mathematical problems and the like? Let the facts speak for themselves:

1. Mr. T——, of Metuchen, New Jersey, writes: "I had earnestly been trying to make a trial-balance, and had at last left off working—the summary of the Dr. and Cr. sides of the account showing a difference of £2 10*s.* 0*d.*, the Dr. side being so much smaller. The error I had not found on Saturday night when I left the counting-house. On this same Saturday night I retired, feeling nervous and angry with myself. Some time in the night I dreamed thus: I was seated at my desk in the counting-house and in a good light; everything was orderly and natural, the ledger lying open before me. I was looking over the balances of the accounts and comparing them with the sums in the trial balance-sheet. Soon I came to a small account having a debit balance of £2 10*s.* 0*d.* I looked at it, called myself sundry uncomplimentary names, spoke to myself in a deprecating manner of my own eyes, and at last put the £2 10*s.* 0*d.* to its proper side of the trial balance-sheet, shut up and went home. Here the dream abruptly ended. I arose at the usual Sunday time, dressed carefully, breakfasted, went to call upon some young lady friends, and to go to church, especially with one of them. Suddenly, the dream flashed on my memory. I went for the keys, opened the office, also the safe: got the ledger, turned to the folio my dream indicated. There was the account whose balance was the sum wanted, and which I had omitted to put in the balance-sheet where it was now put, and my year's posting proved correct."

2. Mrs. R——, of Wakefield, Rhode Island, writes: "When perplexed by work, often leave it and find the thing easy after a little while. Once, while working at a chess-puzzle for several evenings, I went to bed, fell asleep, and worked it correctly; sprang out of bed, found it correct, and wrote it down for fear of forgetting it; found it right in the morning. I had worked at the puzzle so long that it was perfectly familiar, and, before going to sleep, lay thinking of new moves; the right one was merely a continuation of my waking thoughts."

3. Mr. S——, of New York city, writes: "I remember but one instance, in which case, when about nineteen years of age, I correctly solved a mathematical problem, during a sound sleep, so far as I could judge, which had puzzled me before going to bed."

4. Mr. F——, of Brooklyn, New York, writes: "I was studying algebra, in which I was quite interested, and had an example to do in six unknown quantities. I worked at it in the evening, and after an hour or two gave it up and went to bed. That night I dreamed the way to do it was so-and-so, and arrived at the right answer. On awakening in the morning I tried it before I got up, and, following the way suggested in the dream, got the correct answer."

5. Mrs. B——, of New York city, writes: "In guessing double acrostics, of which I am very fond, I often carry a question on in my mind without giving it any particular attention, until at last the answer suddenly occurs to me."

6. Mr. F——, of Westerly, Rhode Island, writes: "Have worked out many algebraic or geometrical problems during sleep. Have, when some years ago in Worcester Academy, scanned some fifty or seventy-five lines of Virgil, not yet translated, except ten or fifteen, felt tired, went to bed, in sleep accurately translated all of it, and remembered it on waking."

7. Mrs. B——, of New York city, writes: "In reading a difficult language, I read the text over without attempting to translate, getting as much of the sense as this perusal may give; then I leave it for a few hours and return to it later, to find its difficulties solved—this is not the case when the second follows directly on the first."

8. Dr. S——, of New York city, writes: "I remember, when in college, having been engaged all the evening in working on a geometrical problem and going to bed with it unsolved; having an uneasy sleep, in which I dreamed of geometrical figures and of working with them; and, on awaking in the night, the solution of the problem suggested itself to my mind, which solution I remembered and found correct next day."

9. Mrs. X——, of Paterson, New Jersey, writes: "Have played a game of whist in my sleep and deplored the mistakes I have made while awake; gone over the whole game, replayed it in sleep, with much better results and to my entire satisfaction."

The following cases belong to the same class, and demonstrate that perception in consciousness often occurs long after the perception of the fact has been fully grasped by the individual unconsciously. The discussion of the relations of consciousness to unconsciousness will appear later:

10. Mr. B—— (a Frenchman) writes as follows: "I once received a French letter from Paris, describing a race, and ending with the English words, "O how I am sorry!" I could not decipher the words when awake, but it came to me in sleep as it was written, and I made it out perfectly then."

11. Mrs. D—— writes as follows: "On one occasion, having written a note, I received a note which conveyed to my mind the idea that the writer had entirely misunderstood my communication. I fell asleep

while composing a reply which should set the matter straight, and awoke with an instantaneous certainty that an erroneous punctuation had obscured the writer's meaning, which in reality coincided with my intention and required no answer. Evidently, the mental accuracy was greater when asleep than when awake—very humiliating."

12. Mrs. P——, of Omaha, writes: "I have many times heard remarks, the significance of which I did not fully comprehend at the time, and weeks afterward have had them flash suddenly into my mind with all their import."

The statistical result is as follows: About eighty-five per cent of those answering claim to have arrived at definite results of work begun in consciousness and left unfinished—at results of a finished logical nature—at results that could come only by bridging the gap between the beginning and partial continuation in consciousness, and the perfected conclusion by predicating the existence and operation of unconscious intellectual effort as the necessary cause of the known result. Fifteen per cent state that they have no experience concerning the phenomena inquired about. Of those answering affirmatively, nearly fifty per cent give examples to corroborate their assertions.

Fourth. The fourth division is of intellectual activity producing new ideas, creations, and inventions, when there has been no conscious beginning. Does such work proceed in unconsciousness? Some of the facts brought to light by the circular are as follow:

1. Miss P——, of New York city: "While reading the 'Evening Post' I happened to observe an anagram offered for solution. The anagram was, 'Got a scant religion.' I read the paragraph aloud to a friend sitting near me, and then turned to something else, a novel in which I was interested, and which quite absorbed me, and gave the anagram no further thought. I never consciously thought of the anagram until the following morning, when, as I was walking and trying to recall a dream, the word 'Congregationalist' flashed through my mind. The word had no connection with my dream, and came to me so suddenly and involuntarily on my part, that I was obliged to think for a moment before I could connect it with anything, and then it occurred to me that it was the solution of the anagram which I had read the evening before."

2. Mr. P——, of Omaha: "I had to perform endless multiplications at school as a task, and suddenly became conscious of a law governing the process which enabled me to attain the result almost instantaneously; discovery flashed into consciousness as a clear conception."

3. Mrs. H——, of Bergen Point, New Jersey: "Have often awakened with a part of an essay all ready, with a letter wholly prepared once or twice, with a few stanzas composed on subjects that I had endeavored to treat in rhyme; once or twice also on subjects that I had not attempted or thought to write upon in verse; example, 'The Edu-

cated Alligator,' which you have. These, on waking, have come into memory without effort."

4. Mr. S——, of New York city: "In my senior year at college I had an essay to write that troubled me unusually. After trying to decide upon the subject until quite late, I fell asleep and dreamed not only of the subject, but of the analysis and of all the details. The next morning I wrote out just what I had dreamed, and found it far more satisfactory than anything I had ever done in the same line before."

5. Mrs. H——, of New York city: "Yes, many times. A carol (the author is unknown), which has been sung in many of our New York churches, came into my mind, words and music simultaneously, after I had been reading till long past midnight. There was nothing in the book to suggest the carol, and I was walking toward the door for the purpose of retiring, when the words and music came to me as involuntarily and distinctly as if it had been something to which I was an unexpected listener. So with similar productions—I often write as if from dictation—quite unprepared for what is coming," etc.

6. Mrs. ——, of New York city: "I have written a good deal of verse of various kinds—sometimes this has flashed into my mind as a clear conception, but more frequently slower. In one case, I wrote a long piece, of a rather satiric character, in easy rhythm, as fast as I could set down the words, and it needed little or no revision—usually I am dissatisfied with my first copies."

7. Mrs. ——, of New York city: "In half sleep, after consciousness is gone, I am frequently startled wide awake by the recollection of some forgotten duty—or by some entirely new idea, usually something that is practical in character, and works well when put into shape. Measured by my normal standard, these ideas are usually above the medium in clearness and precision, completeness and practical value. They are new thoughts, but rather expedients, business suggestions; for instance, the idea of writing a series of articles for 'Scribner's Monthly' on microscopic studies of vegetable and animal life in its completeness came to me in this way—articles which appeared and have since appeared in book-form, and laid the foundation of most of my work since."

8. Mr. S——, of Philadelphia: "While walking alone, busily engaged in trying to settle a business question—so intent as to have my head down, and quite oblivious to anything around me—an original conundrum presented itself to my mind. (I confess to a slight weakness for punning, but rather despise conundrums, and this is the first and only one I ever concocted.) The conundrum was as much an interruption of my course of thought as if another person had come to me—it was, 'Why is so much bread baked? Because it is all (k)needed.'"

The results of the answers in this subdivision may be summed up

as follows: Only thirty per cent claim to have suddenly discovered the results of creative effort, which they would venture to call new, in the line of practical inventions, poetry, literary conceptions, mathematical solutions, and the like; these creations appeared suddenly, most often while the individuals were engaged on matters foreign to the discovery. About forty per cent do not answer the question, and thirty per cent answer in the negative, while, of those answering affirmatively, only about twenty-five per cent are able to give examples.

III.

To clearly apprehend the significance of the facts thus set forth, it is necessary to understand thoroughly the conception of human consciousness. The chief difficulty which obscures this subject is a lack of proper differentiation between self-consciousness and consciousness, in their several relations to human unconsciousness. Self-consciousness is the intellectual perception by which the *ego* recognizes the *ego* as seeing, thinking, judging, feeling, etc. Consciousness, though often confounded with self-consciousness, is not a synonym for it, but is merely the environment in which self-consciousness is manifested. Human consciousness is not an intellectual property or state of the mind—it is purely a state of nervous activity; it is nervous energy in a most intensified form. Human unconsciousness is a less intensive state of nervous activity, wherein self-consciousness can not be manifested.

Nervous activity is ever the same in kind, and, while there is a great difference between the simplest reflex action and the highly developed state of consciousness, yet this is one of degree alone. Intellectual activity is ever present in the brain, and every moment is producing new results without cessation from birth to the grave. As a condition precedent to the existence of these results of our changing thought-life, the brain requires a supply of blood commensurate to the calls made upon the nervous energy and corresponding to the intensity of its activity.

There is a broad belt of border-land between consciousness and unconsciousness, whose limits are uncertain, yet where the manifestations of intellectual activity are recognized, which prove the kinship of the life of those two great regions. The world judges each individual by his intellectual activity manifested in consciousness. Upon this our judgment of him is based, as this can be the only known or possible method of determination. Many "mute inglorious Miltons" undoubtedly exist, yet for the world they do not really exist. Shakespeare produced the character of Hamlet, Hamlet came through the door of Shakespeare's consciousness to greet and astonish the world, yet Hamlet and Lear and all the glorious company of Shakespeare's known creations represent not a tenth part of the finished idealized conceptions of character that were born in Shakespeare's brain while

he, unconscious of his labor, acted or wrote or dreamed after an evening of sack at the "Mermaid" with "rare Ben Jonson."

That indefinable personal equation which distinguishes the individual from all others is the limit and condition of his unconscious intellectual activity. Newton discovered the workings of the law of gravitation and happily perceived it in his phase of consciousness, and the world has become so much the wiser on account of this accident. The workings of other laws of Nature he undoubtedly formulated to just as definite and logical conclusions, yet these he and the world have never known. It is most improbable that Sir Isaac Newton in consciousness or unconsciousness ever created a finished ideal like Becky Sharp or the Heathen Chinee. The novelist Dumas, after a period of active living and omnivorous reading, would board his yacht on the Mediterranean, and lie half torpid and dreaming day after day on her deck, hardly noticing his environment; then suddenly would change from this state and betake himself to work, summoning into existence the results of his unconscious intellectual activity, dashing off chapter after chapter, not of some work on theology, but of a novel. So perhaps were Chicot and the immortal Athos, Porthos, and Aramis conceived. The limitations of the personal equation forbid the idea of an intellectual activity existing in unconsciousness unlike that found in consciousness. On the contrary, we are forced to predicate an absolute relation in kind between the results of such activity in the two distinct phases of our life; just as when we see the fossil types characterizing a Silurian stratum cropping out horizontally on some hillside, we can as surely determine what will distinguish the fossil forms of the interior of that hill as if we summoned an army to remove the incubus and lay bare for our scrutiny the stratum at the center.

Having once possessed knowledge, we can never lose it; the power to use it may be temporarily lost, but there is no knowing when the proper chord may not be struck, and the old fact of memory or the old problem long worked out may not be regained. All our experiences may fade away into the realm of unconsciousness, yet they are not lost, they are only dormant and biding their time. In consciousness we find the means by which we can exercise self-consciousness, and thus know our own existence. In this most specialized form of purely nervous activity, the *ego* is discerned as an *ego* endowed with reason, will, and conscience. What the genesis of consciousness from unconsciousness is, we know not; there is as great a gap here as the step from nothing to life, and there we must stop, seeing our limitations with reverent agnosticism and recognizing the folly and futility of further investigations. The materialization of consciousness has been ordered by science and it must be recognized as a fact. Mind and body unquestionably react, but the psychologists have, in the past, mingled too great an amount of matter with mind, and science is now surely, but certainly and with pitiless accuracy, separating the

two, pointing out the clay that was mixed with the metal supposed to be pure, and relegating the baser substance to its proper place. The fact that consciousness is a mere phase of nervous activity, pertaining to the body and consequently of the earth, earthy, has nothing to do with the mortality or the immortality of the *ego;* it is an argument neither for nor against the existence of a soul. A dog possesses clearly defined consciousness, and yet it is not necessary to predicate a soul as the accompaniment of this possession; to argue thus is to degrade the meaning of the word soul. Consciousness is but a part of normal flesh-and-blood existence; it is nourished and stimulated by a generous supply of healthy blood, and becomes changed and unhealthy by disease. It seems probable that in the vast land of unconsciousness, intellectual activity becomes manifold, and each of the many sides of our nature, untrammeled by the restraints of conscious volition, carries on a ceaseless activity, the results of which we sometimes receive and recognize in consciousness.

OUR ICE-SUPPLY AND ITS DANGERS.

By T. MITCHELL PRUDDEN, M. D.

IT is not easy to realize that the region which we now call New York was once a mass of bare, tangled rock, bound fast beneath vast glacial ice-fields, which, stretching away to the north and west, held all northern North America in the bonds of a dreary desolation.

The gigantic fissure through which welled up from the earth's center that vast mass of molten rock which we call the Palisades, had closed fast upon its sides long before the last reign of ice began; and when at length the cold era was established, and the great glaciers, with their slow, resistless flow, came sweeping down, year after year, over the top of the Palisades, across the rocks on which New York stands, and at last broke off and melted in the sea, the ice-mass, and the fragments of stone which it had torn loose in its progress and held fast along its sides and bottom, planed down the rocks over which it passed, and left upon their exposed surfaces broad grooves, shallow channels, and innumerable scratches, which to-day tell silently the story of that ancient reign of ice. The house-building *furor* is fast removing these ancient records, but in the upper parts of the island and on the top of the Palisades one still may see large numbers of glacier grooves and scratches.

How long this ancient Ice age lasted it would be useless to conjecture now; but at length the climate changed, and by little and little the ice relaxed its grasp. The stones and bowlders, with which it was so relentlessly grinding off the surface of the earth's crust hereabout, dropped from its fingers and lay much as we may see them

now in some parts of the track of the North American ice-belt, scattered or piled in masses where the ancient moraines were gathered, miles from their kindred rock. And now over the surface of the bare, forbidding region, slowly as the ages passed, crept the verdure which, out of rock and air, was to recreate the world. Probably long before man made his appearance, on this part of the continent at least, the ice had all melted and gone to waste. He came, however, at last, the savage, the Dutchman, and—most perfect bloom—the New-Yorker.

In the early days of New York village life the stolid citizen was far too busy to spend much thought on luxuries, in adapting himself to the untried conditions of the New World and maintaining his foothold against the wiles of his savage neighbors. His gustatory sense had, with characteristic directness, been contented for the most part with plain unadorned rum when it felt the need of extraneous stimulation, and this and other simple drinks were either taken *au naturel* or re-enforced by the addition of spices under the kindly offices of fire. Water, which the early citizen may, in moments of relaxation of the mental fiber, have playfully regarded as a beverage, was largely derived from wells, and thus might be had of sufficient coolness to be palatable under natural conditions.

Half a century ago twoscore wagons sufficed to distribute all the ice which was used in New York; but the demand steadily increased, until now nearly three and a half million tons are harvested annually, in favorable seasons, in the vicinity of New York. Few realize how much the comfort and welfare of all classes, especially in the summer months, have come to depend upon that free use of ice which its abundance and cheapness make possible. Untold dangers from the consumption of spoiled meat and other fresh foods are warded off through its preservative action, and their market value largely reduced. And who can adequately realize the comfort and even life-saving agency of ice among the sick and injured? When the charities of New York are summed up, the free distribution of ice-water in some districts of our city should not be reckoned as among the least important.

Perhaps of any single class of consumers of ice the brewers use the largest quantities, to control the high temperature which accompanies the fermentation of the wort; but for this purpose processes of artificial cooling have, to a considerable extent, replaced the natural ice. Ice-cream makers and market-men are also among the most important consumers. The experiences of the writer would hardly justify him in enlarging upon the multifarious concoctions into which ice enters before they are handed by the white-aproned autocrats over the more or less attractive bars of our no longer temperate town to gilded and brazen youth and statesmen, or to their humbler *confrères* and constituents more commonly only dirt-adorned. On the whole, in spite of its not infrequent abuse when used for drinking purposes in large quantities and at unsuitable times, ice is one of the most indispensable

of the accessories to modern life, especially in large towns; and it is wholly to our credit that its free use has become a really noteworthy national trait.

New York has its ice-speculators and its Ice Exchange, and the Ice Exchange has its bulls and bears, who watch the thermometer and the weather as intently as their *confrères* in another market watch railroad-construction and the ticker. An ice-trade journal, published in Philadelphia, does valiant duty in endeavoring to establish the position of the ice-trade among the great industries of the world.

From twenty to twenty-five million tons of ice are annually harvested in the United States, and not far from fifty million dollars are invested in the business. It is probable that we use more ice annually in the city of New York alone than is consumed on the whole Continent of Europe. It is said that, if all the ice-houses on the Hudson River below Albany were placed side by side, the line would be not far from seven miles long! If we estimate the bulk of the entire amount of ice annually harvested in the vicinity of New York each year, we find that, if piled in a solid mass one hundred feet square, it would make a column soaring nearly three miles into the air. We have thus a veritable return of the Ice age—on quite a small scale, it is true, in comparison with that which Nature brought about by tilting up the strata and lowering the temperature of North America a few degrees; but then man always cuts a rather sorry figure when his "tinkerings" with the elements are brought into contrast with the results of Nature's wholesale and forceful work. A certain amount of ice is brought to New York from Maine each year, but the quantity is not large except after open winters, when the crop hereabout has been a poor one. Norwegian ice, with which England is largely supplied, has been at times brought here in small quantities, but under ordinary conditions it can not compete in the market with the domestic product.

Rockland, Highland, and Greenwood Lakes; Swartout Pond, near Rockland Lake; an artificial pond called Lake Meheagh, on Verplank's Point; Tuckahoe Pond, on the Bronx River; Van Cortland Pond, in the new Van Cortland Park; Ice or Hinkley's Pond, on one of the small tributaries of the Croton River; and Lake Mahopac—all furnish varying amounts of ice for our market. But the Hudson River between Poughkeepsie and Albany forms the principal source of our supply. In the earlier days of ice-harvesting on a large scale upon the Hudson there was a good deal of quarreling among the representatives of the various companies as to their rights to particularly favorable ice-fields, and lively skirmishes over evanescent and uncertain boundary-lines took place between the employés of rival companies, with the natural sequelæ of broken heads and noses. But with legally acquired rights to the water-front on or near which the storage-houses are built, and the occupation year after year of particular tracts upon

the ice, these picturesque struggles, which recalled in little the frequent encounters between the retainers of rival houses in feudal times, have passed away, and the scene of personal encounters is mostly transferred to bar-rooms. But the modern representative (God save the mark!) of feudal times now and again stirs up discord in the form of strikes and their retroactive accompaniments among the ice-harvesters.

The days when the most approved manner of storing ice was to dig a hole in the ground, fill it with ice, pack straw around it, and cover it tightly, leaving some primitive mode of access, have long since passed, and some of the larger storage-houses are not only moderately tasteful in their construction and ornamentation, but are fairly imposing in size. The better houses, mostly of wood, have efficient drainage at the bottom. The walls are hollow, containing an air-chamber, and within this a chamber filled with some non-conducting material, such as sawdust or hay, while above is a loft with abundant ventilation. The larger houses are divided into a number of rooms, so that when they are opened for the removal of the ice the whole mass need not be exposed to the warm air which enters.

The cakes of ice, which in this region are cut of a uniform size of about twenty-two by thirty-two inches, are usually laid flat, a solid stratum at the bottom. Above this they are placed on top of one another with two or three inches of space between their edges, the joints being broken every few tiers, as in masonry, by allowing the cakes to lap over the joints below. The object of the space between the edges of the cakes is to prevent their freezing together, for if this occurred their removal would entail a good deal of additional labor in breaking them apart, and a large loss of ice which would be chipped off in the operation. When the houses are about full, a solid layer of cakes is laid on top, so that the air may not circulate between them, and the whole is covered by hay. A varying number of smaller buildings are usually clustered about the storage-houses, such as engine-house, tool-house, shop, barn, and often the boarding-house for the men.

But let us leave these dry details and get out of doors, lest Winter should steal a march on us, and we should lose those first delicate crystal spiculæ shooting out from shore and rock with which he commonly begins his work alike on lake and stream and pool. Who does not know those fragile ice-fringes, losing themselves in the open water, which the first frosty nights in autumn leave behind often only to fade away in the next day's sun? But when at length, after these early, playful exhibitions of his gathering power, Winter really bends himself to his work, the crystals grow longer and thicker, their sides join, and finally the completed film formed along the surface shuts in the water, and his dominion is complete. Now his tactics change. The caprices which he has displayed as the long crystals stole out in ever-varying directions from the shore are subdued, and the stern work of

strengthening his fetters fairly begins. After the first film of ice is formed, the freezing goes on directly downward as the heat from the water radiates off into the colder air above. The direction of crystallization has changed, and is now at right angles to that in which it began. Unhindered radiation of heat from the water out into the air is the secret of the continued formation of ice. If anything occurs to prevent this, the ice stops forming beneath. A fall of snow upon the already-made ice greatly retards its continued formation.

Some of the elder ice-harvesters still foster a feeble flame upon the broken altars of the old star-worshipers in their belief that the cold rays from the winter moon and stars favor in some mysterious way the growth of their ice, since this forms best on the clearest nights. Who would dispel this chaste illusion by suggesting that the clouds which draw themselves at times over the faces of their gentle deities delay the fruition of their hopes simply by preventing the escape of the earth's heat off into space? In the vicinity of New York, where open winters are so common and changes of temperature are so great and frequent, the formation of the ice is a matter of the greatest solicitude to the ice-farmer, upon whose vigilance and judgment may largely depend both the value and abundance of his winter's crop.

Let us suppose that Winter is fairly in possession along the river. The storage-houses, machinery, and tools for harvesting the ice are in order. Many of the horses which have dragged the last year's crop in its daily distribution about the town have been brought up on the returning empty barges to recruit a little before their winter's work begins. The men who are to engage in the harvesting are beginning to straggle in to make their arrangements. A certain number of these are regular employés of the companies who work in town during the summer. Then along the Hudson many of the workers are farmers from the adjacent country, who, not over-busy in the winter, come down singly or in squads, looking upon their term of service to the ice companies as a sort of lark with a pecuniary bias. Then there is a large number of rovers, living, Heaven only knows how, through the rest of the year, who straggle along the river, work long enough to keep themselves drunk for a day or a week, and then brace up for another turn on the same or on a different field.

While all these forces are gathering toward the ice-harvesting centers, the superintendent is keeping a sharp lookout on the formation of the ice. The field has to be staked out as early as possible in order to secure it against invasion by competitors. It used to be necessary to make a fence four feet high around a pre-empted ice-field in order to legally secure it, but stakes or twigs stuck in the ice four feet apart are deemed sufficient now.

While the weather is clear and cold, and the colder and clearer the better, all goes well with the growing crop as slowly the water yields itself into its crystal bonds, and the domain of the clear, solid ice creeps

downward inch by inch. But this condition of affairs, quite ideal from the standpoint of the ice-farmer, is apt in this region to be evanescent. If the grip of the cold relaxes by day, the formation of ice may stop, and even a film of that already made may melt away in the water beneath; but at night again another layer may be added, and so, with many halts, retreats, and slow advances, little by little the ice-mass thickens. But who would imagine that, written in the ice, as plainly as the sequence of geologic ages is written in the rocks, is the record of these alternate victories of heat and cold as they contended for the mastery of the water during the winter days and nights? Strange as it may seem, the record is there, however, and, stranger yet, is written in air. Look at the edge of a cake of ice which has formed in comparatively still water during such alternations of temperature as are common in our winters, and you will be very apt to see a series of bands of transparent ice, between which lie layers of tiny air-bubbles. In still water, when the ice for any reason stops forming for a time, bubbles of air from the water or from the bottom are apt to rise and collect beneath the ice, and when the freezing again begins they are entangled and held fast between the old and the new ice-layers, a permanent record of the relaxation of the thrall of the cold long enough for their collection. In running water such bubbles are apt to be swept away, and the ice remains transparent.

While the ice is thus forming the ice-farmer looks on, his spirits rising in inverse ratio to the height of the thermometer. To the vagaries of the temperature he must reconcile himself as best he may. But let his *bête noire*, the snow—if so violent an antithesis be permissible—appear, and he will be on the alert at once. The snow-flakes, delicately adjusting themselves to one another as they settle down upon the ice, build up among their crystals myriads of tiny air-cavities, and the whole forms a veritable blanket which hinders radiation. It is warm for the same reason that a down comfortable is—it prevents the escape of heat. Now, what shall our ice-farmer do? It does little good to swear at the snow, although he usually has recourse to this procedure first. If the already formed ice is thick enough to bear the teams, he may scrape the snow off, and then the freezing can go on. But if not, he sends his men over the field to cut small holes here and there through it; the water wells up, flows over the top, forming a layer of slush, a good deal of the air is expelled, and the whole freezes, forming a whitish layer which is called *snow-ice*. This layer is whitish because of the air-bubbles which it still retains, but it conducts off the heat fairly well, and his crop goes on forming. This operation is called "tapping" or "bleeding" the ice. Ice which has a very thick snow layer is called "fat ice." This snow-ice is not as valuable as clear ice, for householders object to it because they fancy that it is not so pure, and the assurances of the dealers that the impurity is only air appear to have little weight. So the more responsible dealers usually find it

for their interest to remove most of the snow layer. A little snow-ice on the cakes, however, makes them keep better. We shall see by and by that there are really very good reasons why the snow-ice from certain sources should not be used for drinking purposes.

At last the vicissitudes and anxieties of the growth of the ice-crop are over, and the "boss" decides that the cutting shall begin. A good deal of responsibility attaches to this decision, and many factors must be considered. If a good thick mass has formed, say from ten to fourteen inches, the sooner it is under cover the better. But if the weather has been fickle and warm, and the layer is only from four to six inches thick, it is a more difficult matter to decide. It is better to have six-inch ice in the houses than none at all; but if by a little delay two or three more inches could be secured, it would be an immense gain. But, on the other hand, while waiting for the added increment, warm weather or a freshet may suddenly come on, and the whole crop be lost. Repeated snows upon the ice are bad; an untimely breaking up of the ice by a freshet is worse. But if, during the freshet, the whole field is swept away, there is often still a chance for a new crop to form. About the worst combination of misfortunes—and it is not so very infrequent—is for the ice to soften, to be all jumbled up and mixed with dirt and *débris* of various kinds from above by a freshet, and then, before this mongrel and well-nigh useless mass can be swept down stream and away, to have the whole thing freeze solid on the spot.

The first step in the ice-gathering is to draw two long, straight lines on the ice at right angles to each other. With these as a guide, a part of the field is marked off into blocks of the proper size, and it then looks like a gigantic checker-board. Then other teams come on, drawing the ice-plows, which are long, narrow-toothed blades, running along the ice like great horizontal saws. One plow follows another along these narrow grooves until they are deep enough, so that long strips of the outlined cakes may be readily loosened by a saw. These separated strips of ice grooved off into cakes are pushed along in a channel which has been cleared through the ice up to the foot of the endless chain that runs up an incline to the houses. Here the strips are broken apart along the deep cross-grooves into cakes by hand-bars shaped like great chisels. The cakes are now caught upon projections from the elevating chain, moved by steam, and up they go one after another to the platforms at varying heights around the ice-houses, or directly in at the main door. When the cakes enter the storage-rooms they are shoved along wooden runs or movable tracks to various parts of the chamber where layer by layer they are stowed away. Sometimes a single inclined plane with its endless chain leads up to a series of platforms along the front of the building, which tier above tier slope gently away from the top of the incline, so that the ice-cakes, leaving the chain at the center, are slid down the platforms

to the various openings. The ice-mass, which is quite imposing as one looks across it in the larger houses, must be carefully and skillfully packed, and be self-supporting. Many a dealer has come to grief by the fall of his building from the collapse of the ice-mass within. The construction of the great and elaborate ice palaces with which the people of Montreal and St. Paul sometimes amuse themselves in winter is comparatively simple, because water is poured in between the blocks, and the whole freezes to a solid mass as it rises. But the art of the commercial ice-builder consists in making his ice-mass solid enough to stand alone with just as little freezing together of the cakes as possible.

The more responsible harvesters are particular about the appearance of the ice which is stored, and if a block is dirty from inclosed sand, grass, weeds, etc., it has to be thrown away. That sounds very simple, to throw away a cake of ice. But if one fancies that, in doing it, the offending object is dragged bodily off by hand out of the way, he underrates the value of machinery, gravity, and American enterprise. No, the offending block is floated on toward the elevator along with the rest, and goes up in line like any reputable sheep. But its Nemesis awaits it at the top in the person of a man with a spiked stick, with which he unceremoniously bounces it off the end of the platform into a heap of broken ice below by one quick, skillful thrust.

Too much ice must not be grooved out by the plows in advance, lest in case of rain the channels should fill and freeze solid and the labor be wasted. So it is frequently necessary for the workers at the plow to be out long before light in the morning, grooving out blocks for the harvesters when the day begins. It is a picturesque sight, these hardy men, muffled to their ears, following the gingerly-treading teams back and forth over the ice-fields by the light of flaring, smoky torches hung on poles stuck in the ice. More than once the swinging lamps which have done patriotic duty in some campaign torch-light procession have found themselves relegated to the austere and chilling duty of illuminating hoary ice-fields before the dawn, instead of lending force to the political claims and convictions of would-be or would-continue-to-be American statesmen after dark.

Serious accidents are not frequent upon the ice-fields, but occasionally a horse breaks through or slips off into the icy water, and has to be hauled out with ropes. The men, too, frequently enough, get an unexpected bath amid the jeers of their fellows. A change of clothing and a stiff horn of whisky are the not unwillingly endured penalties which such an awkwardness entails.

At Highland Lake, which lies in the hollow of a natural rocky terrace a short distance back from and above the Hudson below West Point, no power other than that of gravity is used in carrying the ice to the houses some distance away. A wooden runway leads from the edge of the lake down the hill. Down this the ice-cakes glide one after another as they are fed in directly from the water-level above.

When the cakes approach the storage-houses they enter the top of a great wooden tower, in which the runways form a huge spiral. Down this they slide with diminished velocity, and may be switched off at any desired level directly into the houses.

In good seasons a considerable quantity of ice is usually "stacked"; that is, piled up in great heaps outside of the houses and covered up with hay or straw. This ice is shipped early in the season, and the housed stock saved for later use. Sometimes a considerable quantity of ice is carried over from one year to another, and serves as an insurance against bad seasons. When winter is coming on and navigation liable to close on the river, all the available boats and barges are filled with ice and sent down stream, and from this stock the early winter deliveries are made. When this is exhausted, the supply may be drawn from the houses which are in communication with the city by rail, or the ice may be cut near these houses, put into the cars, and forwarded directly.

The insurance of ice-houses against fire, and in many regions against wind, is an important matter. For, singularly enough, the destruction of these buildings by fire is of such frequent occurrence that the insurance rates are quite high. They seem to be favorite playthings of the lightning, and it is probable that the shelter which the lee and sunny sides of these large and often isolated structures afford to that most disgusting combination of man, brute, and devil, the modern tramp, would account for a considerable number of ice-house fires.

The ice used in New York is largely brought to town in barges or canal-boats, though a considerable quantity, notably that called Croton Lake ice, from Ice Pond and Tuckahoe, comes in by rail. The ice-barge, so familiar an object upon the river, is a singular, awkward craft, with a great square house upon the deck, with slender derricks in line fore and aft, and a small windmill at one end for pumping out the water as it accumulates from the melting of the ice. The New York ice-dealers are greatly favored by the extensive water-front of the city, which enables them to almost entirely dispense with expensive storehouses in town, the ice being for the most part loaded from the barges directly into the delivery-wagons.

The delivery of ice in New York is largely controlled by the companies which harvest it, by whom drivers are employed to supply their customers. There are other concerns which make contracts for ice on the large scale from the harvesters, and sell and deliver to their own customers. But there is still a large number of men called "bush-whackers" and "guerrillas," who work up custom in various sections of the town, and get their ice where they can from the regular dealers.

We are all familiar with the appearance of the ice-wagon, heavy and usually clumsily built, a slight tilt of the body forward, painted with any of the colors of the rainbow, or more commonly with colors which the rainbow would blush to acknowledge, and adorned with

some more or less attractive name. The name on the ice-wagon, often apparently indicating the source of the ice, may or may not actually do so. A large part of our ice comes from the Hudson River, and, as a rule, whenever and wherever Hudson River ice is more conveniently and cheaply delivered than that from any other source, this is what the consumer gets, no matter what the flaring legend of the cart may seem to imply.

Except the grocer, who visits us in guises as varied as are the wares which he dispenses, the ice-man is that one of the outside ministrants to our wants with whose appearance we are most familiar. Few escape hearing the infernal clatter of the ash and garbage carts, which, under the new *régime*, leave a trail of murdered sleep behind them in the early morning, or the uncanny whoop and screech of the milk-dispenser. But they do not form such constant features of the street-life as do the ice-carts and their officers after the world gets fairly astir. We have all watched with interest the skill with which the experienced ice-man cracks off his larger and smaller rectangular blocks, and the ingenuity which he exhibits, when it is not carried in-doors, in selecting a sunny place for its deposition on the steps. The never-failing attraction of the ice-cart for peripatetic children is the occasion of many picturesque street scenes, and not infrequently of serious accidents, for every now and then an ice-block falls off behind, and woe to the youngster who happens to be in its way, for ice weighs about fifty-eight pounds to the cubic foot.

There is yet another phase in the story of the ice which we must not overlook. We have been wont to believe that the fragment of ice which forms such a constant and pleasing adjunct to our glass of water is the very ideal of purity. But the common belief that, in freezing, water purifies itself from all kinds of contamination, has been shown to be quite untrue; and, ungraceful as is the task of dispelling so pleasing an illusion, we shall do unwisely if we ignore the revelations of modern science, and for the sake of a momentary mental quietude remain oblivious to a real danger which the indiscriminate use of ice for drinking purposes unquestionably entails.

Nearly all natural water contains considerable numbers of tiny vegetable organisms called bacteria. So small are they, for the most part, that thousands upon thousands of them, if ranged side by side, would scarcely reach across the head of a pin. Most of them are not only, so far as we know, entirely harmless when taken into the system in moderate quantities, but they are among the most important factors contributing to the cleanliness and continued salubrity of our surroundings. Wherever under ordinary conditions a bit of organic matter, animal or vegetable, dies, these tiny structures appear and tear it to pieces, atom by atom, using a very small proportion as food, and furnishing the remainder in suitable innocuous form for the nutrition of animals and other plants in turn. There seems to be at first something

repellent in the thought that we are liable to unwittingly consume, in our drinking-water, as we do in much of our uncooked food, such numbers of living things. But this feeling is largely due to the wholly unjustifiable disposition which many persons display to class them among "bugs" and "worms." Nobody thinks of considering the consumption of fresh fruits and vegetables as anything uncanny. And yet all the vegetables and fruits which we commonly use as foods are really made up of vast aggregates of tiny living organisms called cells, each one of which is the analogue of the single organisms called bacteria, and under ordinary conditions one is just as little harmful as the other. The leaves and fruits of some plants are exceedingly poisonous, and yet he who should on that account decline to eat lettuce or peaches would be justly reckoned among Nature's weaklings. The air we breathe in inhabited regions always contains considerable numbers of bacteria, but they are for the most part harmless.

We have learned a great deal about these, our invisible friends the bacteria, within the past few years; and as that knowledge has grown, we have found out that lurking among them are a few species, not friends but our most inveterate foes, producing disease and even death. The fact is that, under ordinary favorable sanitary conditions, the bacteria which we are liable to breathe or consume are as harmless as so much air. But if we insist upon drinking dirty water or breathing filthy air, we increase, as we deserve to do, our risk of coming under the influence of the baneful forms.

There are a few diseases common among us, the most important of which are consumption and typhoid fever, which are caused by the presence and action in the body of certain well-defined and well-known species of bacteria. These diseases never occur except under the influence of these particular forms of germs. And the reason why consumption and typhoid fever continually occur is because certain of us get some of these bacteria in the living condition into our bodies, where they grow and induce the disease. All persons are not alike susceptible to the action of these bacteria, naturally or at all times, so that they doubtless not infrequently gain access to our bodies without producing ill effects. Now every intelligent person knows, or ought to know, that water polluted with sewage is not a proper thing to drink; and, while there may be other causes which render it unwholesome, the cause which we know most about is the presence of certain forms of disease-producing bacteria. This knowledge it is which has led to the construction for large towns of expensive systems of water-supply, whose reservoirs are situated at considerable distances, where, presumably, no sewage contamination is possible. If we can be certain that the water from our city supplies can not contain sewage or human or animal excretions of any kind, we are pretty safe, so far as our present knowledge goes, in giving ourselves little concern about the number of bacteria which it may contain.

But let us return to our ice. He who is familiar with the researches of Tyndall and other physicists on the structure of ice, knows how little we can be aware, from the simple inspection of a lump of clear ice, beautiful as it is, how marvelously it is built up crystal by crystal into the solid form we know so well. But if we turn a beam of sunlight upon it, concentrated by a lens, the exquisite and varied steltate figures which flash out within the solid mass as the magic touch of the sunbeam releases the molecules of water from their crystal bonds, give us enchanting glimpses of the still but half-won secrets of beauty and of order with which Nature so fondly sports and still so cleverly conceals.

But the resources of the physicist do not suffice to conjure all its secrets from a block of ice. It is left for the student of that phase of Nature which we call life to discover that this very type of cold impassive lifelessness may be fairly teeming, absolutely transparent though it be, with whole families and races of living things—dormant from chill it is true, but ready at the touch of warmth, and in the presence of their food, to start on a career of growth and multiplication to which the increase in the world's populousness since the old Ice age faded is but a poor and halting comparison.

We can not follow the student of these lowly forms of life, which have become entangled among the ice-crystals, as he calls them back from their torpor, separates them one by one, and patiently studies their life-history. It is not enough to melt the ice and look at the resulting water through the microscope. But he mingles the melted ice with a transparent compound of gelatin and beef-tea, and puts the whole in a warm place, and after a few hours or days, wherever in this semi-solid gelatin a living germ from the ice had lain, a tiny speck or rounded mass appears—a "colony" he calls it—which is made up of thousands of the descendants of the old rescued and thawed bacterial ancestor. And so the biologist can separate the species one from another, cultivate them in various receptacles, and learn whether they belong among man's friends or foes.

A great deal of careful experiment has shown * that water in freezing largely expels its coarser visible contaminations, and also that a large proportion of the invisible bacteria which it contains may be destroyed, even as many as ninety per cent. But still large numbers may remain alive, for many species are quite invulnerable to the action of cold. It has been found that in ice formed from water containing many bacteria, such as water with sewage contamination, the snow-ice almost invariably contains many more living bacteria than the more solid, transparent part; so that the snow layer should be especially avoided in ice obtained from questionable sources.

Unfortunately, the bacteria which cause typhoid fever are not readily killed by cold, and may remain alive for months, fast frozen in

* See the New York "Medical Record," March 26 and April 2, 1887.

a block of ice. But the typhoid-fever germ can be present in water, so far as we know, only when it is contaminated with refuse from persons suffering from the disease; so that, if we can be certain that our ice was cut from water uncontaminated with sewage or human waste, we have nothing to fear from its use so far as this disease is concerned. All of the pond and lake ice supplied to New York is of fairly good, and most of it of excellent quality; and no doubt the danger of contracting typhoid fever from the use of the larger part of the Hudson River ice is quite remote. But a considerable quantity of the Hudson River ice is cut just below Albany, where the stream is so greatly contaminated with the sewage of two large towns, Troy and Albany, as to be absolutely filthy. In both of these towns typhoid fever is of frequent occurrence during the period in which ice is forming, and the waste from the victims passes directly into the river. There would, therefore, seem to be a very real danger in the use of *some* of the Hudson River ice.

The responses which one commonly meets when he has occasion to point out the possibility of danger from the use of impure ice are apt to be, "How horrid! Why do you add another misery to life?" or "Our fathers have never suffered from the use of ice, and why should we?" etc. No sanitary danger has ever been pointed out, and no improvement instituted, which had not to stem just such opposition. The cesspool has given way to the sewer, and the well to the distant water-supply, in the face of the same sort of silly protest on the part of many of those whose own most vital interests were at stake—persons who ignore the fact that an ever-increasing vigilance is necessary to ward off the dangers which the aggregation of large numbers of people in cities invariably entails. The danger from the use of impure ice in New York, though wide-spread, is not very alarming, so far as the liability to extensive outbreaks of typhoid fever are concerned, because most of the ice which is furnished appears to be of fair quality. But if the risk of an attack of the disease can be warded off from one in ten thousand of our fellows, the gain is worth the effort. We do not need to be unduly squeamish, but it is well enough to be intelligent in the face of sanitary dangers. The ice companies, unless controlled by the State Health Department, will doubtless continue to cut and to furnish sewage ice along with the rest just as long as their customers will tolerate it. But if householders would insist upon the assurance that their ice should not come from the immediate vicinity of Albany, or from directly below other towns draining into the river, the companies would soon recognize that acquiescence in this reasonable demand is the wiser and more profitable course.

We are a long-suffering people here in New York, and, if our common manifestations of patience were commendable instead of contemptible, we should be deserving of monumental record. We are, it is true, saved in a measure from swill-milk, bob-veal, and numerous

other abominations, by the vigilance of our health-officers. But we smilingly swallow the dirt which the horse-car companies order thrown upon our streets to save themselves the expense of roughening the roadway in a legitimate manner; we allow the elevated railroads to rain dust and cinders down into our eyes, and drop oil and water upon our heads and shoulders; we stumble over boxes and baskets stored upon our sidewalks; we permit political tricksters to juggle with our lives, even with Asiatic cholera staring us in the face; we breathe, in some of our most popular, expensive, and fashionable theatres, air which, from lack of adequate ventilation, rivals that of crowded tenements and the steerage of stuffy steamships; and in innumerable other ways are the victims of the money-making and money-saving instincts of our fellows. But, after all, the complacency with which we swallow the frozen filth which some of the ice companies at times deliver at our doors—albeit often very clear and harmless in appearance—because it is cheaper for them to harvest it where the sewers empty than elsewhere, affords a spectacle of self-abasement as melancholy as it is disgusting. If the householder be not brave enough to encounter the scorn of the ice-dealer, or is too tender-hearted to witness the picture of injured innocence which he often presents when the details of his business are called in question, the ice which is used for drinking purposes may be put in a separate receptacle, so as not to come directly in contact with the water.

Our space does not permit us to consider the growing importance of the manufacture of artificial ice. But it seems probable that the sanitary problems which the use of natural ice for drinking purposes presents, especially in large cities, may find their solution in the increasing employment of artificial ice made from distilled or otherwise purified water.

And now, at last, as we look at the old Ice age and the new together, we find that, while in some respects alike, they differ widely in their significance and in their relationship to man. The mysteries of the old ice-crystals perished with them; the grandeur of the great glaciers passed unseen, leaving desolation. What hardy germs were caught up by the ice as the last cold period came on, and were swept from one part of the continent to another, we can only conjecture.

The new Ice era came in response to the intelligence and the growing refinement of the material needs of man. Petty as it is in its physical proportions, when set in fancy beside the old, it overtops it in significance, because it owes its very existence to the comfort and healing which we compel it to bear. Our blocks of ice can to-day be made to yield up their secrets of marvelous physical constitution, and we can read out of their inmost recesses the dainty records of the elemental warfare which silently went on, as now heat and now cold was victor in the water where it slowly formed. We can nurse back to life the delicate organisms which were sporting in the water

when it fell under the spell of Winter's wand, and wring from them one by one the secret of their relationship to man—framing the pass-words by which we are to know whether they belong among his friends or foes.

The use of ice should, and doubtless will, become more and more universal and liberal as time goes on, and we may unreservedly hail as a triumph of enterprise and skill, and a cherished factor in the advancement of man's weal, the advent and growth of our New Age of Ice.

FLAMINGOES AT HOME.

By HENRY A. BLAKE.

I DO not know if much has been written on the subject of the breeding of flamingoes, or if their habits have been closely examined; but I have a distinct recollection of a print in a book on natural history read by me many years ago, where the flamingo is depicted straddling on a very high nest, with the legs hanging down on either side. I have always thought this to be rather a peculiar way of sitting during incubation, and, finding that the birds bred in large numbers in the islands of Inagua, Andros, and Abaco, I determined to satisfy myself by personal observation as to the manner in which these birds sit on their eggs while hatching.

The flamingoes are very shy, and are only found in the remote and rarely-visited lagoons. When seen in flocks of some hundreds standing in long lines, they look at a distance like battalions of British troops on parade, their brilliant pink plumage showing up well against the dark-green mangroves with which the lagoons are generally fringed.

In May they begin to repair the old nests, or to raise new ones, which is done by scooping up the surrounding mud with the beak, while they stand on the nest and pat it into shape and proper consistency with the foot. It is no mere treading on the mud, but one foot is used at a time, and the sounding slaps with which the cones of mud are got into shape can be heard at a considerable distance.

The nests are always grouped close together, sometimes as many as four hundred being found in a "rookery." They stand from three to four feet apart, the area occupied by each nest being about twelve square feet. The birds do not always return to the same breeding-place, and if disturbed much while breeding, or if the very young birds are taken from the nest, they will probably breed next year in some other rookery, many of which are to be found in the least accessible parts of the great stretches of swamps.

Having settled upon their breeding-ground for the year, the old nests are at once taken possession of by the oldest or strongest birds, who proceed to repair them by adding to the top the inch or more

washed off by the rains since last tenanted. If the nest is very low, four or five inches may be added, and sticks, shells, or anything else that may be lying about the base, are scooped up and worked in without any apparent arrangement, just as if the soft mud with the *débris* contained in it were lifted with a trowel and placed on the top. There is no preparation made for the new repair of the old nest, and, if an addled egg remains, it is simply covered over with the fresh stuff and built into the cone. I measured some scores of nests. The highest was fifteen inches, the lowest eight inches, the latter being the height of the nests in the first year. The nests were about eighteen inches in diameter at the bottom, and nine to eleven inches on the top. The concavity was very slight. In a few cases about half a dozen feathers were found on the nest, but in general the eggs were laid on the bare mud. I said "eggs," but, out of some hundreds of nests examined by me in June, there were not half a dozen which contained two eggs, one being the usual number. As some of those taken at the time were in an advanced stage of incubation, it is probable that at each breeding-season but one egg is usually laid.

THE FLAMINGO.

The nesting-season is from the middle to the end of May. The young birds are hatched about the end of June or beginning of July, and about the first week in August are so fully fledged that, while some can fly, almost all are capable of taking care of themselves. It is at this time that the young birds are taken, sometimes by scores. As the nests are in places so difficult of access, and the birds could not be carried without danger of breaking their slender legs, the problem of getting them to the shore for shipment would be difficult to solve, were it not that a flock of young birds are easily driven. When they are first approached, those who can fly get up and circle overhead, but in a very short time they pitch with the other young birds now being driven away, and they do not fly again. The entire lot are then driven like a flock of sheep over the flat banks of marl or through the shallow lagoons. In the molting-season the old birds are sometimes thus driven, as they can not then fly.

I left Nassau on the 3d of June, and, having called at several places on the way, dropped anchor at Bustick Point on the evening of Monday, the 6th of June. Bustick Point is on the island of Abaco, the eastern side of which is fringed with a line of bays forming an almost uninterrupted belt of land, with a few deep passages through which ships can enter. On two of these bays are built the settlements of Hope Town and Green Turtle Bay, the principal towns of Abaco. Between the bays and the shore of the island the beautifully clear water of the Bahamas is always smooth, and the sailing is delightful, the changing views of island and bays affording constant interest.

We had arranged with two guides to meet us, and at 5 A. M. on the 7th of June we landed. I was accompanied by Lord George Fitz-Gerald, and Lieutenant Robertson, Second West India Regiment. The air was still, but the morning was fresh and bright, and the walk across the island was most enjoyable. The ground was picturesquely rugged, and the path led up and down and around low hills planted with pineapples, of which great heaps of the full but green fruit were piled upon the shore ready for shipment, while the golden hue of the fruit with which the trees were still crowned showed that much of the crop was already too ripe to bear the voyage to a foreign market. All the care of cultivation could not keep down the creepers of all kinds that covered every available stump; white and purple passion-flowers and wild grape-vine fringed the path. Convolvuli of various hues opened their bell-shaped flowers to the morning sun, while the broad, green leaves of the bananas planted here and there were jeweled along the edges with sparkling dew-drops.

Beyond the pine-field we entered a thick wood, completely carpeted with maiden-hair and other ferns, while almost every tree was laden with orchids. Over the crest of the hill the scene changed. The wood ended and the path plunged downward through bracken so thick and so high that the morning-glory climbed the stem to thrust its bright, blue bells into the fresh morning air. One expected to see the deer start from its lair, and nothing was wanting, save the melody from the woods, to fancy one's self in an English park on a summer morning.

Beneath us the broad, lake-like lagoon stretched away to the dim distance. Not a ripple ruffled its surface, and on its calm breast, as in a mirror, were reflected two rocky islets, whose precipitous sides were crowned with a tropical wealth of vegetation, while over them wheeled in graceful circles a pair of "johnny-crows" found in the Bahamas on the islands of Abaco, Andros, and Bahama only. Away on the horizon to the west were low clumps of mangroves showing where the flat banks of marl begin among the lagoons of which the flamingoes build.

Fastened among the great mangrove-trees that here fringe the

NEST OF THE FLAMINGO (ACCORDING TO THE OLD BELIEF).

lake we found a boat belonging to William Albury, one of our guides, and pulled away for the western shore. The lake, or lagoon, is here about five feet deep, the bottom soft, and covered with slimy weed. Albury, who is a keen old sportsman, informed us that the wild pigeon breeds about the lake, and in the season he shoots large numbers of them. If, however, they fall into the water, there is an end of them, as the lagoon is infested by numbers of small sharks, which not only snap up the birds, but are particularly bold—so much so that to swim for the pigeons would probably result in a serious bite, if not worse. I confess that I received this information with a certain amount of reserve, my experience being that sharks are very cowardly in these waters, so that even large ones rarely attack men. However, about two hours later, when we had pulled to the other side, where the waters were so shallow that all hands were obliged to wade, and drag the boat over the sharp rocks, covered with small univalve shell-fish, on which the flamingoes feed, I had ocular demonstration of their boldness. We had observed the ripple caused by a shoal of bonefish, when suddenly a small shark by which they were being chased turned and came straight for the bare, black legs of Edgar Archer, our second guide. He flung an oar at it, which missed it, but caused it to sheer off. The fish was only about two and a half feet long, but the determination to try the flavor of Archer's legs was unmistakable.

Hauling the boat high and dry, we started for the nests. By this time the sun was very strong, and, as the soft marl banks, sparsely clothed with dwarf mangrove and button-wood, afforded no shade, the walking was decidedly hot. The banks are penetrated in every direction with the arms of the lagoon, now almost dry, but after south-westerly winds they fill so that a boat will float in them. The nests are always built in these lagoons or on their brink, so that when the water rises the nests are almost awash. Indeed, in rough weather the eggs are sometimes washed out of them. The birds can thus feed while sitting.

A walk of about an hour brought us to a small clump of trees, from behind which we carefully reconnoitred, and there, within half a mile, we saw the birds. Very lovely the pink mass looked in the bright sunlight. There were three separate clusters of nests, every one of which was occupied, while the male birds stood around, their heads raised high, as they evidently suspected mischief. As I could not clearly make out with my glasses the position of the legs of the sitting birds, there was nothing for it but a long stalk over the intervening slob, and with the blazing sun now almost vertical. The first quarter of a mile was comparatively easy, as we could creep on our hands and knees; but then we came to a point where nothing but vermicular motion could avail us, and for real hard work let me recommend it to those who are content with very active exercise without attaining a high rate of progression. The tropical sun beat down upon

us, hatless as we now were, from a cloudless sky; but I suppose that our profuse perspiration saved us from any ill effects, the rapid evaporation counteracting the sun's heat. It may be that I was too anxious about reaching a favorable point of observation to think of it, but I can not say that I even suffered any inconvenience.

At length, having crawled under the roots of the dwarf mangroves that covered the slob like a network of croquet-hoops, we found ourselves at the edge of the marl, and within one hundred and fifty yards of the birds, who were still undisturbed. Here, with my glasses, I could see every feather, note the color of the eyes, and watch every movement. There were, we calculated, between seven hundred and a thousand birds, and a continuous low, goose-like cackling was kept up. Never did I see a more beautiful mass of color. The male birds had now all got together, standing about five feet high, and with necks extended and heads erect were evidently watching events, preserving in the mean time a masterly inactivity. Now and again one would stretch out his great black and scarlet wings, but the general effect was the most exquisite shade of pink, as the feathers of the breast and back are much lighter than those of the wings.

The hens sat on the nests, and some were sitting down in the muddy lagoon. I watched them carefully for nearly an hour, and looked at every nest to see if the legs were extended along the side. In no case did I see a leg. I saw the birds go on to the nest and sit down. I saw them get up, and step down from the nest. In every instance the legs were folded under the bird in the usual manner. In my opinion my observation settles the point as to the mode of sitting; for even if, as I had been assured, the birds sit both ways, it is improbable that among the hundreds then sitting not one would have extended the legs. Remembering the great length of the flamingo's legs, it is evident that on a new nest, not more than eight inches high, the hen could not thus sit, nor would even the highest nest allow of the legs being extended while the bird sat upon it.

After having watched the birds for the time named, we showed ourselves; but whether they had observed us before, and become somewhat accustomed to our presence, or that when sitting they are more easy to approach than I thought, the only effect was that the hens left the nest, and, joining the male birds, prepared for eventualities, nor did they take wing until we had begun to walk up to the rookery. While we were examining it, the birds flew round us within forty yards, so that we could have shot them easily. Of course, we did not do so. To prevent the destruction of flamingoes and pigeons by their wholesale slaughter during the breeding-season, the Bahamas Legislature passed in 1885 a Wild Birds' Protection Act, from which I hope for good results.

Having taken a few eggs as specimens, and lifted carefully on to a board a nest destined for presentation to the Zoölogical Society,

which was carried safely to the ship on the head of Edgar Archer, but unfortunately broken afterward by a clumsy sailor, we started for the yacht. On our way back across the lagoon we pulled to a high clump of mangroves, in which the frigate-birds build every year. There were some scores of them sitting among the branches, but no nests had yet been built; nor could we discover in the clefts of the small rocky island near the landing-place the nest of the "johnny-crow," which breeds there every year.

In due course we wended our way back through the sturdy bracken and the silent woods. The morning-glory had already changed its blue coat for one of deep purple, and the leaves looked thirsting for their nightly draught of dew. We quenched our thirst with the warm juice of the pineapples cut fresh from the trees, and a plunge overboard into the clear cool water soon removed every trace of fatigue. —*Nineteenth Century.*

CURIOUS FACTS OF INHERITANCE.

THE strength of the law which determines the transmission of character—physical or otherwise—from parents to children is still far from receiving due attention and recognition. A striking instance of inheritance is often hailed as wonderful and inexplicable; yet such cases are merely exaggerated examples of a phenomenon of which every family, nay, every individual, affords proof. We all inherit, in a more or less variable degree, the physical constitution and the mental aptitudes of our parents; but this law of inheritance is liable to so much modification, that frequently its operation becomes entirely lost to view. When two forces act upon a body, the resultant is a mean between the two components. This mean is not merely in all cases different from either component, but it is a variable mean, the variation depending upon the relative strength of the two component forces. Inheritance affords an exact parallel to this elementary law of mechanics. No child is entirely like either parent; and the inheritance of two sets of tendencies which may be allied, opposed, or indifferent to each other, may result in characters possessed by neither parent. This result is no breach of the law of inheritance, but is in strict harmony with its most precise conditions; yet it is not surprising that a law subject to such indefinite variation should gain scanty recognition except from those who have made it a special study, and can, therefore, readily distinguish an explicable exception to a law from an actual breach of it.

That the law of inheritance should be constant in its operation, however variable in its effects, is not a matter for surprise. That like produces like is the law written upon the universal face of Nature. Sir Henry Holland truly observes that the real subject for surprise is

not that any peculiarity should be inherited, but that any should fail to be inherited; and Darwin remarks that the most correct way of viewing the whole subject would be to look at the inheritance of every character as the rule, and non-inheritance as the anomaly.

It is obvious that instances of inheritance are most likely to be noticed and recorded when the inherited peculiarity is striking and abnormal. Countless instances of inheritance come under our notice almost every day; but the vast majority of them are too slight and insignificant to attract attention. A slight peculiarity of feature, complexion, or voice will readily pass unnoticed; but if a striking deformity be inherited, or some disease pursue a family through several generations, it can hardly escape the most careless observation. Cases are on record of families whose members were characterized by the possession of a supernumerary digit on the hands and feet, and this remarkable peculiarity has been transmitted through five generations, showing how strong is the force of inheritance even in such a minor detail of structure. A still more singular instance is that of Lambert, the well-known "porcupine-man," whose skin was thickly covered with warty projections, which were periodically molted. He had six children, who were similarly affected; and two of his grandsons inherited the strange peculiarity. The writer is acquainted with a gentleman who has a marked drooping of the left eyelid. His son inherits this peculiarity, but in a less remarkable degree. One of the most singular instances of inheritance is that recorded by Decandolle. There was a family in France of which the leading representative could, when a youth, pitch several books from his head by the movement of the scalp alone, and he used to win wagers by performing this feat. His father, uncle, grandfather, and his three children possessed the same power to the same unusual degree. This family became divided eight generations ago into two branches, so that the head of the above-mentioned branch is cousin in the seventh degree to the head of the other branch. This distant cousin resided in another part of France, and on being asked whether he possessed the same faculty, immediately exhibited his power.

Haller, the celebrated physiologist, records that the family of the Bentivoglio all possessed a tumor which used to swell when a damp wind blew, and this strange peculiarity was transmitted from father to son. The frequency among the Romans of surnames indicating some physical peculiarity—Naso, Labeo, Bucco, Capito—would seem to show that the fact of certain types of feature being transmitted through several generations had already been remarked. This fact lies almost unnoticed under many current forms of expression. We speak of a certain type of face being aristocratic or the reverse, by which we mean that physical features characterizing certain classes are transmitted so surely as to become the recognized appanage of those classes. The aristocracy of Western Europe pride themselves

upon possessing and transmitting small hands, the outward and visible sign of long exemption from manual labor. The aristocracy of China pride themselves on the smallness of their feet. The implication is in each case the same. We often speak of "blue blood" without any clear idea of the meaning of the expression. The phrase probably arose from the recognition of the fact, that the aristocratic and luxurious classes, who are exempt from actual labor, possess a fine white skin, through which the veins show themselves clearly, and that this peculiarity is transmitted from generation to generation. It is a fact of history that Frederick William I of Prussia succeeded in producing a stock of gigantic grenadiers by matching his tallest soldiers with women of similar proportions.

No point of structure is too minute to afford instances of the law of inheritance. A little spot on the iris has been transmitted from parent to child. The possession of a few abnormally long hairs in the eyebrows has been known to characterize the various members of certain families; and the characteristic of a patch of prematurely gray hair has been transmitted through several generations. Many curious records exist of families which possessed and gloried in their scars, moles, and other family marks, faithfully transmitted from parent to child—a sort of secret hall-mark stamped by Nature to attest the genuineness of the line. Peculiarities in the structure, arrangement, and even in the chemical composition of the teeth, frequently run in families. The writer, among whose professional duties the frequent inspection of tongues holds a humble but not unimportant place, has remarked a notable peculiarity in the shape of that organ transmitted from mother to daughter.

Peculiarities in the expression of the face are frequently inherited. Many cases may be remarked where an inherited resemblance is quite latent when the features are in repose, but comes out with startling vividness when they are agitated by emotion. Among the acquaintances of the writer is a gentleman who, when smiling, exhibits a most peculiar and unusual arrangement of lines at the outer angle of the eyes, and this characteristic has been faithfully transmitted to his children.

When we turn to the lower animals, the instances of striking peculiarities being inherited are still more numerous, and have been recorded with greater care and accuracy. Every breeder and trainer is aware of the vast importance of the law of inheritance, and no instance is allowed to escape notice; but it is only in recent years that philosophers have become alive to the fact that in his physical nature man obeys the ordinary biological laws which prevail among the higher animals, and that among these laws the law of inheritance holds the first place. A breed of cattle once existed which possessed only one horn, and this was transmitted. A one-antlered stag has been known to propagate this peculiarity in his offspring. A rabbit

produced a litter in which one of the young was one-eared, and this was transmitted. Many of the most famous breeds of sheep and cattle have arisen through the accidental appearance of some striking peculiarity of structure, which has been preserved by careful selection and breeding. Thus the well-known Ancon or otter breed of sheep, now extinct, arose in the last century in Massachusetts by the accidental birth of a ram characterized by crooked legs and a long back like a turnspit. These peculiarities rendered him unable to leap fences, and as this was a point of great importance to the early settlers, this ram was selected for breeding, and his abnormalities of structure were faithfully transmitted. The breeds of Mauchamp sheep and Niata cattle had a somewhat similar origin. Darwin relates how in a litter of pointer pups one was observed to be of a blue color. This remarkable circumstance led to inquiry, and it was found that, four generations earlier, there had been in the same breed a pointer bitch named Sappho, celebrated for her blue color. We have here an instance of one of the secondary laws of inheritance known as the law of Atavism (from *atavus*, an ancestor). According to this law, any peculiarity, instead of passing directly from parent to child, may skip one or more generations, and reappear lower down in the line of descent. Of this curious law innumerable instances occur. It is not uncommon for a child to resemble his grandparents much more closely than his father or mother. This is frequently noted in the case of animals, where we have the opportunity of observing several generations, and analogy would lead us to expect a similar principle in the case of man. The law of Atavism can only be explained by assuming that the qualities which were *patent* in grandfather and grandchild were *latent* in the intervening generation. There is nothing difficult or arbitrary in this hypothesis, as multitudes of facts are on record to prove that physical and intellectual peculiarities may remain dormant for long periods in an individual, and suddenly develop into prominence under some unwonted pressure. Thus, privation or confinement in an unwholesome atmosphere may develop a latent tendency to consumption. A severe illness has been known to determine the onset of insanity, to which the individual had a hereditary predisposition ; or to take more hopeful instances, a severe shock, such as bereavement or the sudden loss of fortune, has been frequently known to bring out unexpected traits of character, and to develop a resolution and a magnanimity, of which the individual had previously exhibited no evidence. Our characters, in addition to those prominent traits which attract general attention, have a multitude of secret marks traced as it were in invisible ink, and ready to spring into prominence on condition of the necessary stimulus being applied.

When we leave the domain of structural peculiarities and turn to that of mind, habit, and instinct, we find an inexhaustible store of curious facts of inheritance. Contrary to popular belief, there seems

no reason to doubt that genius is hereditary, though, from the obvious conditions of the case, it is rarely transmitted in like quality and degree from parent to child. The subject is too large to be advantageously considered here; but those interested in it will find a vast mass of striking information and ingenious reasoning in Mr. Francis Galton's admirable work on "Hereditary Genius."

A case is on record of a man who possessed the habit of sleeping on his back with the right leg crossed over the left. His daughter, while still an infant in the cradle, exhibited the same peculiarity. The possibility of imitation, conscious or unconscious, is here obviously excluded. A case has been reported to the writer of a man who had the habit of alternately flexing and extending his great toe while lying in bed. His grandson developed the same habit, though quite ignorant of his grandfather's peculiarity. Ribot records a curious instance of a domestic servant who exhibited an incurable vice of loquacity. She talked incessantly to any one who would listen, to animals, to inanimate objects, and even to herself. When upbraided with her folly, she said it was not her fault, as her father had possessed just the same habit, and had almost driven her mother distracted by it!

Instinct is strongly hereditary in animals, even under the most unfavorable conditions. Ducklings hatched by a hen take to water immediately on breaking their shell; and every one is familiar with the spectacle of the distracted mother wildly running to and fro on the margin of the duck-pond, while her youthful family, heedless of her terror, disport themselves delightedly upon its surface. If the eggs of the wild duck be placed under one of the domesticated species, the young, when their feathers are complete, immediately take to the wing. Birds hatched in confinement construct in their cages the same kind of nest as their more fortunate brethren of the same species build in the virgin forest. Many curious and apparently mysterious facts are explicable on the hypothesis of the permanence under changed conditions of traces of aboriginal instincts. Thus, the domesticated dog, even when thoroughly well cared for, is very fond of burying a bone in some secret spot—a lingering trace, probably, of the time when he ran wild in the woods, and the secreting of surplus food for a future occasion was a matter of practical importance to him. When the squirrel is reared in confinement, it stores away in a corner of its cage a portion of the nuts supplied to it, an instinctive preparation for the coming winter, unnecessary, indeed, for this individual squirrel, but highly important for its ancestors and congeners living in the wild state. Every one must have observed how difficult it is to make the common ass leap over a stream, however small. This unwillingness is not the result of an inherent incapacity for jumping, as the ass leaps over other obstacles with ease, while it hesitates obstinately at the tiniest streamlet. We have here, in all probability, a remnant of

an instinct dating far back to the time when the ancestors of the ass were exclusively desert animals, and so unaccustomed to the sight of running water as to be confused and terrified by it. If any one observes a field of lambs at play, he will notice with what delight they frisk upon any hillock within their reach. Here we have probably a trace of the time when the progenitors of our sheep were Alpine animals, and possessed the habits of the chamois.

In the realm of disease, the facts of inheritance are most numerous, and are daily accumulating. Here they are no longer, alas, curious and amusing, but terrible, fateful, overwhelming. No fact of Nature is more pregnant with awful meaning than the fact of the inheritance of disease. It meets the physician on his daily rounds, paralyzing his art, and filling him with sadness. The legend of the ancient Greeks pictured the malignant Furies pursuing families from generation to generation, and rendering them desolate. The Furies still ply their work of terror and death; but we have stripped them of the garb which superstition threw around them, and they now appear to our eyes in the more intelligible but not less awful form of hereditary disease. Modern science, which has cast illumination into so many dark corners of Nature, has shed a new and still more lurid light on the words of the Hebrew Scripture: "The sins of the fathers shall be visited upon the children unto the third and fourth generation." Instances of hereditary disease abound on every hand. Fully fifty per cent of cases of gout are inherited. The proportion is not much less in that fell destroyer of families, our national scourge, consumption. Cancer and scrofula run strongly in families. Insanity is hereditary to a marked degree; but fortunately, like many other hereditary diseases, tends to wear itself out, the stock becoming extinct. Nearly all defects of sight are occasionally inherited. Sir Henry Holland says truly that "no organ or texture of the body is exempt from the chance of being the subject of hereditary disease." Probably most chronic diseases which permanently modify the structure and functions of the body are more or less liable to be inherited.

The important and far-reaching practical deductions from such facts—affecting so powerfully the happiness of individuals and families and the collective welfare of the nation—will be obvious to reflective minds, but can not be dwelt upon in the present article.—*Chambers's Journal.*

An Austrian official report on over-pressure in the public schools recommends as a remedy for the evil, which is pronounced real, a better division of the holidays by giving longer vacations at Christmas and at Easter; and suggests the doing away of the abuses of requiring written exercises, and the committing of too much to memory. Dr. Joseph Heim insists that, whatever reform is adopted, should include the consulting of the physical no less than the mental growth of the young.

SKETCH OF HENRY BRADFORD NASON.

HENRY BRADFORD NASON, Professor of Chemistry and Natural Science in the Rensselaer Polytechnic Institute, Troy, New York, was born in Foxborough, Massachusetts, June 22, 1831, but removed to North Bridgewater when ten years of age. His father, Elias Nason, was a descendant from Willoughby Nason, of Ipswich, Mass. (1712), and was born at Walpole, Mass., in 1768, and died at Easthampton, Mass., in 1853. He was a gentleman noted for his honesty and integrity, and was long engaged in the manufacture of straw and cotton goods; carried on mercantile business; and served his town, Foxborough, as justice of the peace and as Representative in the General Court. The Nasons were living at Stratford-on-Avon in the days of Shakespeare, and a branch of the family still reside there. Professor Nason's mother, Susannah (Keith) Nason, was a lineal descendant from the Rev. James Keith, who was educated at the University of Aberdeen, Scotland, and was the first minister of North Bridgewater (now Brockton), Mass. Having attended school for a short time at Newburyport, young Nason entered the Adelphian Academy at North Bridgewater, in 1843, where his attention was drawn to the study of natural science, and he began to make collections of the local minerals. While attending the Williston Seminary, which he had entered in December, 1847, his taste for natural science grew; he became interested also in chemistry, and enriched his collections with rare and valuable plants and minerals. He cultivated these studies still more assiduously at Amherst College, where he visited the interesting geological points in the Connecticut River Valley; and, under the guidance of Professor Shepard, spent most of his vacations in the mineralogically rich regions of western Massachusetts and Connecticut, making many of his expeditions on foot or on horseback. He studied analytical chemistry under Professor Clark, and assisted him in the preparations for his lectures. Having been graduated from Amherst in 1855, he went to Europe, and was matriculated in the Georgia Augusta University at Göttingen, as a student of philosophy. Here he gave special attention, "with a right good-will," to chemistry, mineralogy, geology, and the German language. He afterward spent some time, greatly to his profit, with Bunsen at Heidelberg, and Plattner at Freiberg. Having returned home, enriched with many specimens of rare minerals and of art, he was appointed, in March, 1858, Professor of Natural History in the Rensselaer Polytechnic Institute. In the following September he was elected Professor of Chemistry and Natural Science in Beloit College, Wisconsin. He divided his time between these two institutions till 1866, when he resigned the position at Beloit, in order to accept the pro-

fessorship of Chemistry and Natural Science at Troy. After a second visit to Europe, he made a tour of geological study in the Southern States in the spring of 1860. In the next year he traveled through Ireland, Scotland, Holland, Belgium, and a part of Germany, and spent a semester in Göttingen in the study of geology and mineralogy, under Walterhausen. He then visited and studied the volcanic regions of Italy, ascended Mount Vesuvius, explored the regions of the solfatara, climbed Mount Etna, examined the glaciers of Switzerland and the configuration of the Alpine regions; and, in France, inspected the natural curiosities of the Puy-de-Dôme. In 1872 and 1875 he made three visits to California, in the course of which he traveled in Nevada and Idaho, and the mining regions of Colorado and Utah, and included in his third trip the Yosemite Valley. He spent the summer of 1877 in northern Europe—Finland and Russia—when he enjoyed as a privilege the traversing of the fields which Linnæus had explored for material for his great botanical work. In the next year he was appointed by President Hayes juror for the United States at the Paris Exposition, and was assigned to the department of mineralogy. Having engaged, in 1880, in the service of an oil company as chemical adviser and expert, he has since devoted much time and attention to the refining of petroleum, methods of testing, and the composition and analysis of crude oils. In the course of these investigations he has been able to throw considerable light on the important subject of the prevention of the nuisances arising from the processes of treating petroleum. In 1881 the New York State Board of Health selected him to be inspector of petroleum-oils, and appointed him a commissioner to London to consider methods of dealing with petroleum nuisances. Another visit to northern Europe, in the summer of 1884, embraced the fiords and glaciers of Norway, and was extended to the North Cape.

Professor Nason's published works include an "Inaugural Dissertation on the Formation of Ether" (1857); "Table of Reactions for Qualitative Analysis" (1865); a translation and revision of Wöhler's "Hand-Book of Mineral Analysis" (1868); "Table for Qualitative Analysis in Colors" (1870); an edition of Elderhorst's "Manual of Blowpipe Analysis" (1873, followed by fourth and fifth editions in 1875 and 1876); an edition of the "Manual of Blowpipe Analysis and Determinative Mineralogy" (1880); and a semi-centennial catalogue, the "Proceedings of the Semi-Centennial Celebration," and a "Biographical Record" of Rensselaer Polytechnic Institution. Besides receiving numerous college and university honors, Professor Nason has been elected Fellow of the American Association for the Advancement of Science; Fellow of the London Chemical Society, and of the Society of Chemical Industry; member of the American Chemical Society, of the New York Academy of Sciences, of the American Institute of Mining Engineers, of the Troy Scientific Association; an honorary mem-

ber of the Albany Institute; and a member of the "Norske Turistforenings," of Christiania, Norway.

Professor Nason, although, as we have seen, he has made a quota of contributions in the way of special studies and publications to the spread of scientific knowledge, is best known as a teacher; and many hundred men, now earnestly at work in fields of engineering and scientific activity, can trace the beginnings of their usefulness and professional devotion to the enthusiasm which they drew from his instructions and example. His assiduous industry and constant labor to improve and develop the educational facilities and appliances of the seminary have contributed no little to the growth of the solid and world-wide reputation which the Rensselaer Polytechnic Institute enjoys. The marks of his work are especially seen in the laboratory, with its three departments—metallurgical and chemical rooms and lecture and study rooms—affording experimenting accommodations for forty students, which was planned and built under his direction. After the mineralogical cabinet of Professor Eaton, which had been rearranged and labeled by Professors Hall and Nason in the previous year, was destroyed by fire in 1862, Professor Nason, who was then in Europe, immediately began collecting the nucleus of a new cabinet, and this is now known as the Henry B. Nason collection of minerals, containing five thousand specimens, which are arranged in several divisions to illustrate their structural, physical, and chemical properties. His name is also closely associated with the botanical rooms, in which one of the special features is a collection of more than three thousand specimens of American and European plants presented by him. As a teacher, he possesses in a high degree the power of inspiring the minds of his students with a love of science for the sake of science. In consequence of his faithful attention to the drilling of the lecture-room, this work absorbing his time and being honored by him as his duty of paramount importance, he has not been as fruitful in the publication of original investigations and the announcement of the new discoveries which he is so competent to search for, as he might have been had he divided his attention more equally between the two branches of his work. His methods of teaching are quiet, analytical, simple, and winning. An eminent writer has said of him: "He is, in my opinion, one of the most competent scientific instructors of our country; he brings to his classes in the laboratory enthusiasm for their inspiration, rich stores of scientific learning for their enlightenment, and is, in himself, in respect to good nature, gentleness of manner, and elegance of language, a model of what they should be." If the workman may be known by his work, the hundreds of engineers and scientific experts who have enjoyed the tuition of Professor Nason are the best evidence of his ability as a teacher.

CORRESPONDENCE.

PROFESSOR HUXLEY AND THE "BLIGHTED FIG-TREE."

Editor Popular Science Monthly:

IN "The Popular Science Monthly" for January, Professor Huxley, writing on "Science and Veracity,"* says: "I do not know any body of scientific men who could be got to listen without the strongest expressions of disgusted repudiation to the exposition of a pretended scientific discovery, which had no better evidence to show for itself than the story of the fig-tree that was blasted for bearing no figs when 'it was not the season of figs.'"

Now this very ignorant fling at Christianity is a fair specimen of the objections generally offered by infidels and semi-infidels. Coming as this does from a man of more gentlemanly instincts than Ingersoll, it lacks much of the impudence of Ingersoll, but it shows the same utter ignorance of the great subject, for Huxley here has shown himself ignorant of the facts in the case by most absurdly assuming that a fruitful fig-tree would only have fruit on it at "certain seasons"; whereas all who know the facts know that the fig-tree in Palestine should have figs on it at all seasons. Hence Professor Huxley's fling has no base on which to rest. It is a sad pity in the interests of mankind, and especially of these men, that they are not willing to give as fair tests of the truths of Christianity as they give to chemistry and other sciences. If they could be persuaded to apply the adequate tests to the claims of Christianity which Christ gave, when he said, "If any man will do his will, he shall know of the doctrine whether it be of God," they would thus have ample proof of all the important claims, and would "know of the doctrine," and, as the greater includes the less, the importance of all these little mysteries would vanish.

Professor Huxley undoubtedly understands much about physical sciences (geography excepted, apparently). But, manifestly, he knows nothing about the science of religion.

He thereby falls into the grossest absurdities in attempting to write of it as Professor Tyndall did in his quintessence of absurd impudence, when he proposed to test the spiritual efficacy of prayer by a steel spring, which proposition is as far and no further from reason than Professor Huxley's assumption is from facts.

J. W. HUNTOON, M. D.

LOWELL, MASSACHUSETTS, *January* 12, 1888.

* "Science and the Bishops."

The obvious comment on the foregoing is, that it affords a "fair specimen" of the proneness of many people, in their extreme solicitude for the safety of favorite beliefs, to see all sorts of bugbears, where to a cooler judgment there is not the slightest occasion for alarm. The passage so excitedly complained of as "this very ignorant fling at Christianity," "a fair specimen of the objections generally urged by infidels," and as showing "utter ignorance of the great subject" is quoted by Professor Huxley from a source that should command the confidence instead of the contempt of our correspondent. For the convenience of the reader we give the passage as it occurs in the Gospel of St. Mark, chapter xi, verses 13, 14.—EDITOR.

"And seeing a fig-tree afar off, having leaves, he came, if haply he might find anything thereon: and when he came to it, he found nothing but leaves: for the time of figs was not *yet*.

"And Jesus answered and said unto it, No man eat fruit of thee hereafter forever. And his disciples heard *it*."

THE INTERSTATE COMMERCE LAW.

Editor Popular Science Monthly:

In your February number there is an article by Mr. Henry Wood on the "Interstate Long and Short Haul," containing some errors of fact which may bear correction. The clause of the Interstate Act which forbids an aggregate larger charge for a shorter than for a longer distance over the same line, under substantially similar conditions, receives severe criticism, and in illustration of its alleged bad effects several instances are mentioned. It is stated (page 540) that the rail-carriers between New Orleans and New York or Boston are not allowed to quote rates in competition with water carriers lower than to intermediate points. This is a mistake; all water competition is considered sufficient excuse for violations of this short-haul section, and the tariffs of our railroads are full of such instances: New York to New Orleans or Mobile, New York to Wilmington, North Carolina, etc., are a few out of many where interior rates are much higher.

Again, in his foot-note (page 541), Mr. Wood complains that the Canadian Pacific competes with our transcontinental roads, which are prevented by this law from accepting a less rate for a longer distance. This is also an error. Our Pacific roads

made a lower through rate from San Francisco to Omaha than to Denver or Lincoln, Nebraska, expressly to compete with their Canadian rival, and complaints against them for this very thing are on file before the Interstate Commission. In their decision upon this short-haul question in the Louisville and Nashville case, the commission recognize three reasons for disobeying the general principle: (1) water competition, (2) foreign competition, and (3) such a position of railroads as would destroy competition if condemned. In regard to this latter excuse there are also illustrations in our tariffs. The Erie Railway makes the same or lower rate from New York to Pittsburg *via* Youngstown, Ohio, than from New York to Youngstown. The Michigan Central quotes a rate of thirty-nine cents from Buffalo to Goshen, Indiana, through Detroit, while charging forty-one cents per hundred to Miles, Michigan, a town thirty miles nearer. This comes through competition with the Lake Shore road, which is the short line from Buffalo to Goshen, while the Pennsylvania Railroad is the short line between Pittsburg and New York.

Into the general question of such a law I do not now enter; but are not the facts which I have given, and which could be multiplied, sufficient to show that the injurious effects of the short-haul prohibition are greatly exaggerated in the article referred to? And is it unfair to ask that something more definite be stated before accepting so sweeping a condemnation?

THOMAS L. GREENE.

NEW YORK, *January*, 1888.

EDITOR'S TABLE.

DARWIN'S EDUCATION.

NO part of Darwin's biography is more interesting than the pages which tell how his powers first manifested themselves, and how they were educated. He shared the opinion of his cousin, Francis Galton, that talent is due to Nature rather than nurture, to innate ability more than to education. Crediting then to Nature Darwin's wonderful aptitude for observation and for protracted pondering over observed facts until they became digested into laws, it is instructive to note how badly his formal education was adapted to draw out and develop his powers. Formal education, we say, for what is statedly taught is fortunately but a small part of what is really learned. Darwin's teaching and training were the best current in his boyhood and youth, the best which a wealthy and most intelligent father could provide him, and this is his comment on his first school: "Nothing could have been worse for the development of my mind than Dr. Butler's school, as it was strictly classical, nothing else being taught, except a little ancient geography and history. The school as a means of education to me was simply a blank. During my whole life I have been singularly incapable of mastering any language. Especial attention was paid to verse-making, and this I could never do well." At Edinburgh University, where he spent two years, the instruction was wholly by lectures; these he found intolerably dull, with the exception of those on chemistry. When he went to Cambridge, the recollection of the Edinburgh lectures was so strong upon him that he did not attend Sedgwick's course. This he afterward much regretted, as it seriously belated his study of geology. He, however, derived great advantage from Professor Henslow's lectures on botany; these he much admired for their extreme clearness and fine illustrations. Otherwise, his incapacity for mathematics and languages made his Cambridge studies unprofitable. When a boy, Darwin was a collector of shells, seals, coins, and minerals; at Cambridge his passion for collecting began to be purposeful, and he confined himself to gathering insects. While his formal education was so meager, his real education was proceeding apace, mainly through friendly intercourse with eminent teachers and promising students of the university, attracted by his charms of mind and manner.

Since the years of Darwin's early life much has been done to improve educational methods, and yet more remains to be done. School, college, and university courses are no longer confined to oral instruction, to language-learning and book-lore. It is found that the direct study of Nature is quite as valuable as the memorization of printed pages, or the ability to write in Latin or Greek. Natural science is vindicating its claim to discipline the important faculties which the study of mere verbal symbols neglects. To Darwin, the ability to describe a cirripede in seven languages would have been an accomplishment of doubtful value; to find the cirripede's place in Nature was an important and attractive task. He improved his faculty for observation by assiduous exercise until it became of marvelous keenness. His delight was in receiving impressions direct from Nature, not in receiving impressions of impressions, such as words convey. His rending and parting of books in his library, regarding them simply as so much material, was thoroughly characteristic.

Darwin's school and university experience emphasizes again the utter inadequacy of any education which makes too much of words — especially the words which only live in lexicons. Because language is a noble faculty, and verbal expression is a power of high importance which can be conspicuous in manifestation, utterance has been vastly overrated in schemes of education. After all, what can be verbally expressed is but a small part of what can be thought, or felt, or done. Who can describe the individualities of tone by which one recognizes a friend's voice, or the peculiarities of feature by which one classifies a face as English or Irish? What successful merchant or banker can fully tell why he expects truth and honesty from one applicant for credit, and the reverse from another? What judge can define wherein the manner of one witness impresses him favorably, and that of another adversely? Who can express in speech the feelings stirred by beholding sublime scenery or the starry sky? Where is set forth in print some detail of how music works its magic — now soothing to reverie, now quickening the pulse, arousing resolve and heroic emotion? In attempting to communicate art and skill, to convey impressions of form and color, language is powerless. Its dominion, though wide, has its strict limits:

"Far out on the deep there are billows
That never shall break on the beach."

Excessive cultivation of powers of verbal expression, excessive addiction to books, cause inevitable neglect of the education of hand, of eye and ear—of the senses which give us, when exercised, full and clear perceptions of the things about us. This neglect, by restricting observation and experiment, robs the reasoning faculty of the material out of which judgments may be rendered and new truth born. When a flower is planted and reared, dissected, classified, and sketched in its natural tints, it is known as it never is known to a mere memorizer of botanical text-books. Iron and sulphur become a student's intimate acquaintances in a laboratory; he learns hundreds of interesting facts about them, and how to recognize them in all disguises. Were he but a text-book scholar, he would know little more of them than their names. It is one thing to learn by rote the distribution in the heavens of the various constellations; it is another and deeper thing to know them as one must to track one's way across wilderness or sea. Progress in manipulative skill has in modern times not only given us truer graphic and plastic arts, it has led to important advances in physics and chemistry, and in surgery made the blind see and the lame walk. Every one who has practiced sketching from Nature has felt the reaction of growing deftness with the pencil upon the powers

of observation and the appreciation of scenery. An artist sees so much more in a landscape than an ordinary observer, that he is justified in thinking that the ordinary observer scarcely sees anything at all. Darwin all his life bitterly regretted that he had not learned drawing when young; yet drawing is quite as easily learned by a boy as writing, and gives him the power of showing in a picture much that can not be described in words. Darwin also constantly lamented that he had not overcome his repugnance to dissecting, so as to practice the art and gain direct access to much valuable evidence. Yet, notwithstanding defects in his equipment, he rose, by what he calls sheer doggedness, to ascertaining through observation and thought one of the greatest laws of organic life. Tested by verbal standards, this great man would not have stood high. His verbal memory was poor. He always found it difficult to express himself clearly and concisely, yet this very difficulty was beneficial in making him think long and intently about every sentence, leading him to correct errors in observation and reasoning. He had the strongest disbelief that a classical scholar must write good English—he thought the contrary to be the case. Of literary style as an indulgence in power over words he evidently thought little; while he acknowledged the vividness of Carlyle's pictures of men and things, he questioned their truth. Darwin, by his life, more convincingly than by what he said, demonstrated the supreme value in education of addressing the senses and the reasoning powers rather than the verbal memory. Few boys are destined to be naturalists, and none may hope to be as great as Darwin; yet the lesson of his life is eloquent to every one surrounded by a world of things to be observed, of testimony to be elicited and sifted, of gaps in known truth to be bridged and filled. Because in times past the area of known truth has been vastly overestimated, and the value of language in the expression of such truth equally overestimated, written creeds, theological, political, legal, and educational, have on all sides blocked human advance.

Apropos of Cambridge and progress in the modernization of its curriculum, it is pleasant to read the recent remarks of Professor Seeley, who occupies the chair of Modern History at Cambridge. On the 10th of January, at the Congress of the National Society of French Professors residing in England, he said: "A crisis in the history of English education is upon us, in that classicism education is once more attacked, and the affirmation strongly made that the interests of practical life must no longer be neglected in our educational system, and that Englishmen must be prepared at school to compete in commerce and in business with their foreign rivals, and for this purpose they will have to renounce in part that training in Latin and Greek which former generations of Englishmen have received. The assertion is made more peremptorily, more impatiently, than ever before. I am myself by breeding a classicist of the classicists. In aim I am most heartily at one with the classicists. At the same time I think that in taking up their position they display a spirit of blind, unreasoning conservatism, such as in politics died out with Lord Eldon. What is to be done if the claims of practical life and those of culture are radically incompatible? I should say that the Master of Balliol laid the best basis for such an arrangement when he pointed out that French might be treated as a stepping-stone to Latin.

"Let us give up the preposterous doctrine that Latin must be learned in order to learn French, and let us teach French in order to teach Latin. In so doing we do not sacrifice literature to

mere business, for the modern languages have literatures as well as the ancient. There exists a French literature which comprises books of poetry, devotion, philosophy, science, history, politics—a literature not less but more extensive and various than Greek and Roman literatures themselves. This literature indisputably excites the same sort of emotions and exerts the same influence as classical literature. It elevates the mind, stimulates the imagination, and forms the taste; in short, there is absolutely no good effect produced by the classical literature which is not also in some degree produced by this literature."

THE CONTRADICTIONS OF SCIENCE.

MUCH ado is often made by persons hostile to science or—which is the same thing—having a partisan interest in opinions which they wish to maintain in spite of science, about the contradictions that mark the development of scientific theory. Because the theories which served a good purpose a year ago, or twenty-five years ago, or a century ago, have been put aside in favor of others that more nearly meet the facts as they are known to-day, science, they argue, is not in the least to be depended on; and therefore objections made in the name of science to any opinion or set of opinions should not be allowed to carry any weight. This is a very popular line of argument, but it is also very fallacious, as a moment's consideration will show. In the investigation of Nature the mind necessarily forms theories as it goes along. Some kind of a theory is almost necessary even to observation; and the theory which, at the moment, best accounts for the facts is the one toward which the mind must incline. This is a law which no one can hope to escape. The most reasonable thing any man can do is to accept from moment to moment the soundest and most comprehensive generalization offered to his thought. If that generalization should be incomplete, or in any way unsound, the quickest way to discover its weakness is to put it to the strain of daily use. The question to ask regarding Science—the only really pertinent question—is as to whether she has not, from the dawn of rational thought, been extending her observations and improving her theories. Is she not, has she not always been, on the road to truth? Has she not already established a great many substantially true theories, and is she not daily adding to the number? If scientific men have been too confident in times past as to the absolute truth of their hypotheses, one good result at least has followed from their over confidence: their partial views have all the sooner been displaced by more comprehensive ones. But because science is progressive, because its work is never done, is it never to venture to criticise opinions that are not progressive? We say that the holder of even an imperfect scientific theory, provided it is the best obtainable at the time, has a perfect right to say to one who holds a view that embodies no scientific theory whatever, but simply contradicts all scientific theory, that he is wrong in holding that view. Grant that the view in question may be in unsuspected harmony with some higher truth or principle not yet discovered, we may still say that, in the absence of a *present* justification in fact, it is not right to hold it as true *now*. Better far to take one's humble place in the great procession that is moving steadily onward toward the goal of a true scientific philosophy, and let the higher views dawn on us in their own good time.

It is a strange accusation to bring against science that it is progressive, that it provides means, from age to age, of expressing all the truth that is at the time obtainable, while reserving full liberty to widen, as circumstances may permit, the circle of its inductions, and consequently the basis of its theories.

If this is something to be ashamed of, where is that which we should admire? The proper answer to give to those who love to point out the fallibility of scientific theories (as if elsewhere there were theories that were infallible!) is that it is better to follow any theory that, so far as our knowledge extends, affords an explanation of facts, than to make crude assertions reposing on no theory whatever. At the same time let us take home to ourselves the lesson that science *is* progressive; that the thought of to-day can not assume to bind the thought of to-morrow; and while we still prefer any rational theory to an irrational lack of all theory, let us not by any undue dogmatism give occasion to the enemies of progress to blaspheme. Science, with all the confessions it has to make of past errors, and all its admissions of probable present errors, is going bravely on. Its very errors have been relative truths, and its service has at all times been the service of truth. Can those who delight and exult in the errors of science say as much for the service, whatever it may be, in which they are engaged?

We noticed, not very long ago, an extract from the article on "Brain-forcing in Childhood," contributed by Dr. Hammond to the pages of this magazine, doing duty apparently as an original article in the columns of the "Public School Journal" of Mount Washington, Ohio. In the January number of the "Canada Educational Monthly," published at Toronto, Ontario, there appeared two of our own editorial articles, one entitled "Culture and Character," the second "Encroachments of the State." The first is duly acknowledged, the second is not. It is quite possible that neither of the journals mentioned borrowed the unacknowledged matter directly from our columns, but it is evident that the journal which *first* borrows without acknowledgment does a very dishonest thing, destroying as it does the lawfully acquired property of another journal in the original matter published by it. We rejoice at every sign of public notice which the "Monthly" receives, and make our contemporaries welcome within reasonable limits to whatever in our columns they may desire to reproduce; only, we should like them always to do us the justice of acknowledging what they take.

LITERARY NOTICES.

ORIGINS OF THE ENGLISH PEOPLE AND OF THE ENGLISH LANGUAGE. Compiled from the Best and Latest Authorities. By JEAN ROEMER. New York: D. Appleton & Co. Pp. 658. Price, $3.50.

In this book political and literary history are combined, each being treated with a nearly equal degree of minuteness, in such a manner that a fair view of the subject is presented from both sides, and the mutual influence and reactions of the ethnic and linguistic development of the English people are plainly exhibited. The author's vindication of this course—if he needed any vindication for doing his work as completely as he could—may be found in the opening sentences of his preface: "The history of a language is, in a great measure, the history of the people who speak it, and of those who have spoken it. It is the history of the many populations, different in origin, manners, and in speech, who have at various epochs occupied the soil conjointly, sometimes in friendly but more often in hostile relations, until people of another race, more powerful than any, have crushed them all, and, taking possession of the land, have divided it among themselves, exterminating all who resisted them, and allowing the rest to live only on condition of their being quiet and doing all the work." The English people and language are a conspicuous example of the product of such a series of revolutions as is here described. The course to be followed in tracing the English language to its sources involves, therefore, a critical inquiry into the origin, character, and distribution of the various races of men—Celts, Romans, Saxons, Danes, and

Normans—who at various epochs have found their way into the British Islands; their idioms and forms of religion, their social and political differences, and their relative progress in the arts of civilized life. If we go back to the beginning of this history, we must take notice of the palæolithic and neolithic men, whose part in the formation of the British people is a totally unknown factor. Still, they have left their marks on the land, and may have contributed more than we know toward shaping its future destiny. The Celts were a factor of more recognized importance, and exerted an influence which is still potent in the character of various populations and in the language. From them are inherited numerous local names; and, "although the Druids committed nothing to writing, the religion of the British tribes has exercised an important influence upon literature. The mediæval romances, and the legends, which for a long time stood for history, are full of the 'fair humanities' and figures of its bright mythology." The Romans contributed a quota, which must have been very considerable at the time, but the outward effects of which were to a large extent washed out by subsequent revolutions and invasions. So that, while English is full of what has been derived from Roman influences transmitted through factors operating intermediately in later times, it is doubtful whether any Latin word in modern English is traceable to that remote period. The visible building up of the English people and their language begins with the institution of the Saxon dominion. When Charlemagne had been crowned emperor, and was aspiring to revive the ancient Roman Empire, it was desirable to avoid complications which might arise from a supposed identity with the continental Saxons who had fallen before the great chief; and the names of *English* and *England* were adopted, in part, it may have been, "as more suitable to proclaim to the world at large a distinct nationality for all the inhabitants of England, possibly divided on minor questions, but having nothing in common with the Saxons of continental Europe." The earliest Anglo-Saxon literature originated in the conflict of Christianity with Anglo-Saxon paganism, in which not the heathen practices and ceremonies were the most formidable impediments to the progress of the Christian faith, but the kind of heathen poetry still current, by means of which the memory and practice of the ancient rites and ceremonies were kept alive in the songs at wakes and festivals. "It was to counteract this influence that the clergy composed Christian hymns and songs in the national language, which, to be effective, had to conform to the taste of the age, and to be made equal to the best poems then extant and admired by the most intelligent of those who had embraced the new religion." Among these works was the great poem of Cædmon. The Danes left their impress in local names and in changes in pronunciation, but the whole influence of their sojourn, owing to the disorders and divisions which it produced, was detrimental; and "it was impossible that in such circumstances the national character should not have become deteriorated, and that the country should not have lagged behind in the career of wealth, the arts, of literature, and of every other line of public prosperity and greatness. Accordingly, at the era of the Norman invasion, England was still a country of no account on the political map of Europe." This event, marking a new departure in the career of the English nation, is, with all that relates to it, treated with fullness of detail in its historical, linguistic, and literary aspects. The earlier history of the Normans is given. The conquest is related. The growth of the Norman-French language in England was followed, after the separation of Normandy, by its decline. Then occurred the fusion of the Anglo-Norman French and Anglo-Saxon English, the progress of which is carefully recorded. The last chapter in this department of the work is upon "The English Language and its Vocabulary"—that is, the development of the language as a self-contained entity—which is treated in a manner similar to that in which the other subjects are considered. The history is illustrated by collections, in separate chapters, of specimens of Anglo-Norman French and of early English, both arranged chronologically to show the changes that took place consecutively in the two languages during the course of the evolution. It is supplemented by an appendix treating of "French

Sources of Modern English," in which are given an historical sketch of the French language and a chapter on its etymology, followed by specimens of early French. Though it is subordinate to the main purpose of the book, the execution of this department is equally satisfactory with that which characterizes the part more closely related to the English evolution. The whole book, so far as our cursory examination allows us to judge of its merits, bears the marks of conscientious research, and of a desire to be careful in statement and omit nothing that might contribute to a clear comprehension of the whole story which it tells and of every part of it. So full a presentment of the facts which it comprises, in their bearings upon one another, can not be so conveniently found in any other one book with which we are acquainted.

WEATHER. A Popular Exposition of the Nature of Weather-Changes from Day to Day. By the Hon. RALPH ABERCROMBY. "International Scientific Series," Vol. lviii. New York: D. Appleton & Co. Pp. 472. Price, $1.75.

THERE is no class of natural phenomena which compels such general and constant interest as that which constitutes weather. The number and importance of human affairs which are affected by rain, snow, and hail, winds, lightning, heat, and cold, make a knowledge of the laws which govern weather-changes extremely desirable. Although the need of this knowledge has been felt from the earliest times, it is only within twenty years that the science of meteorology has advanced so far as to be of much practical benefit. But now that weather-predictions are issued by the governmental bureaus of the United States and other countries, and prove true four times out of five, a wide-spread desire has arisen to know how this baffling problem of the weather has been so far mastered. To satisfy this desire is the object of the present volume. "Many books," says the author, in his preface, "have been written on storms and climate, but none on every-day weather. The whole of this work is devoted to weather, in the tropics as well as in the temperate zone." The more elementary parts of weather-science are treated in the first three chapters, the rest of the book being devoted to explaining the more difficult questions. "This volume is not a mere compilation of existing knowledge, for the results of many of the author's original and unpublished researches are included in its pages—such, for instance, as the explanation of many popular prognostics; the elucidation of the general principles of reading the import of cloud-forms; the classification of those cases in which the motion of the barometer fails to foretell correctly the coming weather; and the character of that kind of rainfall which is not indicated in any way by isobaric maps." In the elementary portion of the book the author tells how weather-charts are made and what they teach, and shows why popular weather-signs sometimes prove true and sometimes fail. He also describes here the various forms of clouds, and notes the prognostics to be drawn from them. In the advanced chapters there is a further discussion of lines of equal barometric height, which is followed by a description of the making and use of the records of the barometer, thermometer, and wind-gauge. The nature of squalls, thunder-storms, blizzards, barbers, pamperos, and tornadoes is next explained. Some account is then given of local, diurnal, annual, and secular variations of weather.

In the last three chapters of the book the manner in which the individual weather disturbances follow one another, and the forecasting which depends on knowledge of these sequences, are taken up. The chief types of weather which occur in western Europe and the United States are given in detail, and are copiously illustrated by charts. In the chapter on "Forecasting for Solitary Observers," which can never be superseded for the use of mariners and herdsmen, the author points out "the best that a single observer can do, who has his eyes to look at the appearance of the sky, and any instruments at his disposal." This chapter will interest all who have any taste for amateur work in meteorology. The forecasting by synoptic charts, as done in central bureaus having telegraphic communication with stations for many hundred miles around, is described in the closing chapter. It appears that forecasting is much easier for some countries than for others. In temperate regions, those countries are best situ-

ated which lie east of a well-observed land-area, because most disturbances in the temperate zone move from the west. Hence, the eastern United States can usually count on timely warning of approaching storms. Still, infallibility can not be expected, however favorable the locality. "It is impossible to suppose," says the author, "that we have yet nearly reached the highest perfection of which forecasting is capable, but still we know enough of the nature of the subject to say with certainty that calculation will never enter much into the science of weather-prevision. Natural aptitude and the experience of many years' study are the qualifications of a successful forecaster. In fact, meteorology is not an exact but an observational science, like geology or medicine."

A MANUAL OF NORTH AMERICAN BIRDS. By ROBERT RIDGWAY. Philadelphia: J. B. Lippincott Company. Pp. 631, with 124 Plates, containing 464 Outline Drawings of the Generic Characters. Price, $7.50.

THIS noble book, embodying descriptions of all the birds known to frequent the United States, was originally projected by Professor Spencer F. Baird, who had collected, in sympathy with its purpose, the great cabinet of American birds now forming a part of the National Museum. The pressure of official duties which fell upon him prevented his completing the scheme, or even carrying it on. The task—or "the privilege," as he expresses it—of continuing the work then fell to the present author, who is known as an enthusiastic naturalist, and especially interested in birds. He has endeavored to make of it such a manual as its projector would have desired to see as the fruit of his conception. The object of the volume is to furnish a convenient manual of North American ornithology, reduced to the smallest compass by the omission of everything that is not absolutely necessary for determining the character of any given specimen, and including, besides the correct nomenclature of each species, a statement of its natural habitat, and other concomitant data; to provide a handy book for the sportsman and traveler, as well as for the resident naturalist. The greater part of the material on which the work is based has been furnished by the collection of American birds and their eggs which forms a part of the National Museum. The collections of the American Museum of Natural History, in New York city; of the Academy of Natural Sciences, of Philadelphia; of the Boston Society of Natural History; and of the Museum of Comparative Zoölogy, at Cambridge, Massachusetts, have also been consulted; and acknowledgment is made that the private collections of George N. Lawrence, of New York city; William Brewster, of Cambridge, Massachusetts; and H. W. Henshaw, of Washington, have furnished indispensable material in the way of extra-limital species or more extensive series of certain species. Not consultation of specimens alone, however, has been depended upon; "for, however much the proper discrimination of species and subspecies may be a question of material, a great deal depends upon our knowledge of the birds in life, their natural surroundings, and other things which can be learned only out of doors. Fortunately, a very large number of accomplished field-naturalists have carefully observed the habits of our birds, and through their published records have together contributed a vast store of information which no single person could himself have gained. To the much that has been gleaned from this source have been added the author's field-notes, collected during the period extending from a recent date back to the year 1863, and embracing many measurements of fresh specimens, notes on location of nests, first colors of bill, eyes, feet, etc., and various other useful memoranda." It is intended to embrace the North American species, as they are included within the geographical limits defined in the American Ornithological Union's check-list. But it has at the same time been deemed desirable to include certain extra-limital species from contiguous countries; such as those which are known to inhabit Socorro Island, off the coast of northwestern Mexico, which is North American in its zoölogical affinities; those species which have been included for the sake of comparison, or on account of the greater or less probability of their occurrence within the southern boundary of the United States; and certain "high-sea" species whose wanderings may make them liable to reach our

coasts as "accidental visitors." The body of the manual—which is preceded by a "Key to the Higher Groups"—consists of technical descriptions of the orders, families, genera, and species, in the general order of diving-birds, swimmers, waders, shore-birds, gallinaceous birds, pigeons, birds of prey, parrots, etc.; cuckoos, woodpeckers, etc.; goat-suckers and swifts, and the perching birds. The appendix gives additional memoranda concerning certain rare or little-known species, and lists of new genera and species, and of genera and species admitted as North American which are not included in the American Ornithological Union's check-list. The index gives a reference to every genus and species described, under both its scientific and its popular name.

INTRODUCTORY STEPS IN SCIENCE. For the Use of Schools. By PAUL BERT. Translated by MARC F. VALLETTE. Revised and enlarged by JOHN MICKLEBOROUGH. New York: D. Appleton & Co. Pp. 363. Price, $1.50.

ONE of the greatest obstacles with which the new scientific education has had to contend is a lack of text-books embodying the true spirit of scientific teaching. This lack is now being rapidly supplied, in each of the several branches of science, with books adapted to pupils of various needs and states of advancement. The present volume is designed as a first book in science for young pupils. The study of Nature is especially fit for the training of the young. In the words of the preface to this book: "It is a well-recognized fact that the cultivation of the sense-perceptions lies at the foundation of all knowledge. These sense-perceptions are converted into knowledge under two conditions: first, by observing differences; second, by observing likeness or similarity." It is in early childhood that the exercise of the senses is most active and most pleasurable. A little training in proper methods of observation at this time is worth more than months spent in memorizing scientific facts at a later period. As the child's interest is not confined to animals, plants, or rocks, to physical, chemical, or physiological phenomena alone, so this book obviously accords with natural development in presenting the elements of all the common branches of science before the pupil is required to pursue advanced study in any one. The work consists of seven parts: Animals; Plants; Minerals and Rock Formations; Physics; Chemistry; Animal Physiology; and Vegetable Physiology. "In all departments of the book the subjects have been treated in a manner to cause the learner to *observe*, *think*, and then *express* the result of the observations in suitable language. The pernicious practice of *memorizing* the text-book, or of requiring the student to *listen*, *recollect*, and then *repeat* the formulated statement of the instructor, can not be too strongly condemned." The favor with which the French original was received is shown by the fact that over half a million copies were sold within three years. The style of the translation is conversational, adhering closely to the language of the author when this is possible. Illustrations have been supplied with a liberal hand. "In the natural history, so far as possible, American species have been substituted for foreign ones; and in the chapter on rock formations, that portion which treats of the continental development of North America has been substituted for the author's geological history of France. In short, such corrections and changes have been made as would materially enhance the value of the book in the hands of beginners in science in America."

MEMOIR OF FLEEMING JENKIN. By ROBERT LOUIS STEVENSON. New York: Charles Scribner's Sons. Pp. 302. Price, $1.

THIS memoir, by one of the first of living English romancers, gives a breathing portrait of a very interesting man. While Fleeming Jenkin's original work in electrical science is a notable part of the world's recent advances therein, it was as a man that he was chiefly remarkable. Professor Jenkin was ardent and impulsive, with little conventional polish, the soul of honor, and a man with whom honesty was a passion. He found in his engineering work a noble opportunity for his love of exactitude and thoroughness. He exemplified how supremely ethical are the tasks of applied science in the demands made on its votaries. During his long voyages, while he was busy laying and recovering ocean-cables, he

showed himself capable of the heroic, with all the added charm of being unconscious about it. And amid all the anxious demands of professional emergencies, domestic affections of the tenderest were never absent from his mind. With him, all the powers of an acute, able intellect were heightened and warmed by a fine emotional nature. The death of several children in a friend's family, through bad drainage, directed his sympathetic interest to the question of wholesome plumbing. As the result of his investigations, he became convinced of the necessity for thorough-going reform. In 1878 he accordingly established in Edinburgh the first sanitary association ever formed, and which has not only had many imitators in Great Britain and America, but done much to convince the public of the strict preventability of a large class of dangerous maladies. This volume has added interest, in that it is to some extent autobiographical of its author, Mr. Stevenson. He shows us incidentally and unwittingly how he has become so thoroughly grounded in his art. His imagination is supplied with clear impressions of actual men; in faithfully observing whom, nothing, however apparently trivial, is neglected. His discriminating judgment and quick sympathy are quite as evident as this faculty of keen observation. The way in which he unravels the skein of his friend's heredity is masterly.

THE EDUCATION OF MAN. By FRIEDRICH FROEBEL. Translated and annotated by W. N. HAILMAN, A. M. "International Education Series," Vol. V. New York: D. Appleton & Co. Pp. 332. Price, $1.50.

THIS work is one of the educational classics with which every teacher should be familiar. Although dealing with first principles, it is not a mass of untested theorizing, but comprises the reasons for the practical method which the experience of a great teacher proved to be successful in the school-room. Froebel's aim is that the pupil shall be educated by self-exertion, beginning with that activity which, while easy and attractive, leads him forward in a continuous development of his powers. In this volume, originally designed as the first of a series, we find the fundamental ideas of the system of methods and appliances to which, fourteen years later, the author gave the name "Kindergarten." The earlier portion of the work deals with general principles, and considers the development of man during infancy and boyhood, the most important doctrines being contained in the first two chapters. In the latter part the chief subjects of instruction are taken up in the four classes: religion, natural science and mathematics, language, art. This is followed by a discussion of the connection between school and family. The translator has inserted at many points biographical and other illustrative notes, and includes in his preface the essential parts of the interesting report on Froebel's Institute at Keilhau, made in 1825, by Superintendent Zech.

ANIMAL LIFE IN THE SEA AND ON THE LAND. By SARAH COOPER. Illustrated. New York: Harper & Brothers. Pp. 413. Price, $1.25.

THIS very attractive book is designed as an introduction to the study of zoölogy for children. While accuracy and freshness have been aimed at in its pages, scientific terms have been avoided as much as possible. In classification, which has not been made prominent, the arrangement of Nicholson has been followed. In arrangement, the ascending scale is pursued, beginning with sponges and ending with man. Such animals as are most likely to interest young people have been selected to illustrate the several orders and classes. Of the study of animals, the author says, very properly, in her preface: "It is far more charming to gain this knowledge from the objects themselves than from merely reading about them in books; and it is therefore hoped that each subject which is treated in these pages will be studied from specimens actually in hand, whenever it is possible to obtain them." A very good substitute for unobtainable specimens is afforded by the abundant and clear illustrations.

OUTLINES OF NATURAL PHILOSOPHY. For Schools and General Readers. By J. D. EVERETT. New York: D. Appleton & Co. Pp. 335. Price, $1.

THIS little volume, by the editor of that standard work, Deschanel's "Natural Philosophy," is designed to be easy enough for

a class reading-book, and precise enough for a text-book. It is written in the continuous style of a general treatise, instead of being cut up into detached paragraphs like a common school-book. Although the book is elementary, its language is adapted to the adult reader and the academy or college student, rather than to the young pupil; but technical terms have been avoided, and algebraic formulas have been altogether excluded. The descriptions are uniformly clear, and are made more effective by abundant illustrations.

CHILDHOOD: ITS CARE AND CULTURE. By MARY ALLEN WEST. Illustrated. Chicago: Woman's Temperance Publication Association. Pp. 772.

THE moral and physical culture of children is treated in this large volume, especial prominence being given to religious teachings. The mental culture which is more properly received at home than in school is also touched upon. The book is embellished with pictures, poetry, stories, and music.

A HISTORY OF ELIZABETHAN LITERATURE. By GEORGE SAINTSBURY. London and New York: Macmillan & Co. Pp. 471. Price, $1.75.

THIS book is intended to be the second of a series of four volumes, by different authors, together comprising a history of English literature. The period covered in the present volume is from 1560 to 1660. The large number of writers noticed seems to leave nothing to be desired on the score of completeness. Illustrative extracts are given from all the important ones excepting the four best known.

PUBLICATIONS RECEIVED.

Pohlman, Julius, M. D., Buffalo, N. Y. Cell-Life. Pp 12.

The Etiquette of Men's Dress. New York: "The Men's Outfitter." Pp. 92. 25 cents.

The Havre de Grace Republican Illustrated Almanac for 1888. Havre de Grace, Md. Pp. 80.

Gilman, D. C. A Plea for the Training of the Hand: Belfield, H. H. Manual Training and the Public Schools. (Monographs of the Industrial Educational Association. Vol. I. No. 1.) New York: Industrial Associations. Pp. 24. 25 cents.

Clapp, Charles, Cincinnati. The Present Truth for the Honest Inquirer. Pp. 20.

Brinton, Daniel G., M. D., Philadelphia. On the so-called Alaguilac Language of Guatemala. Pp. 12. On an Ancient Human Footprint from Nicaragua. Pp. 8, with Plate.

Woman Publishing Company, New York. "Woman: A Monthly Magazine." Vol. I, No. 2, January, 1888. Pp. 78. 25 cents, $2.75 a year.

Wilde, Oscar. "The Woman's World," January, 1888. Pp. 48. 35 cents, $3.50 a year. New York: Cassell & Co.

Hill, Robert T. The Texas Section of the American Cretaceous. Pp. 24.

Gerry, Elbridge T., and others. Report of the Commission to investigate and report the most Humane and Practical Method of carrying into Effect the Sentence of Death in Capital Cases. To the Legislature of New York. Pp. 100.

Treat, E. B., Publisher. The "Don't forget it Calendar" for 1888. New York. 20 cents.

Hicks, Lewis E., Lincoln, Nebraska. Irrigation in Nebraska. Pp. 32.

Smithsonian Institution. Report of Spencer F. Baird, Secretary, for 1886-'87. Washington: Government Printing-Office. Pp. 27.

Photo-Engraving Company, New York. Book of Specimens.

Woodward, F. C. English in the Schools. Pp. 25. Huffent, Ernest W. English in the Preparatory Schools. (Heath & Co.'s "Monographs on Education.") Boston, Mass.: D. C. Heath & Co.

Henderson, J. T. Analyses and Commercial Values of Commercial Fertilizers and Chemicals. Report showing comparatively the Yield of the Leading Crops of the State of Georgia. Pp. 82. Atlanta, Ga.: Department of Agriculture.

Linderfelt, Klas August. Volapük: An Easy Method of acquiring the Universal Language. Milwaukee, Wis.: C. N. Caspar and H. H. Bahn. Pp. 130. Paper, 50 cents.

Canadian Club of New York. Canadian Leaves, History, Art, Science, Literature, Commerce. G. M. Fairchild, Jr., Editor. New York: Napoleon Thompson & Co. Pp. 289, with Plates.

Gilson, F. H., Reading, Mass. The Trees of Reading, Mass. Five Engravings, with Letter-press.

Burgess, Edward S., Washington High-School. Guide to the Student in Botany. Pp. 44.

Illinois State Board of Health. Proceedings of Annual Meeting, January, 1888. Pp. 28.

Comstock, Anthony. Morals *vs.* Art. New York: J. S. Ogilvie & Co. Pp. 89. 10 cents.

Chicago Manual-Training School. Fifth Annual Catalogue, 1887-'88. Pp. 24.

Wilder, Burt G. Remarks on Classification of Vertebrata. Pp. 5.

Smyth, B. B., Topeka. The Age of Kansas. Pp. 8.

Evening Post Publishing Company, New York. A Bill to promote Mendicancy. Pp. 27.

Richardson, C. Gordon. Alcohol: a Defense of its Temperate Use. Toronto: National Liberal Temperance Union. Pp. 67.

Chadwick, John W. A Noble Life. Richard Henry Manning. Pp. 19.

The "How I was Educated" papers from the "Forum" Magazine. New York: D. Appleton & Co. Pp. 126. 30 cents.

Ogilvie, J. S. Seven Hundred Album Verses. New York: J. S. Ogilvie & Co. Pp. 128. 15 cents.

Holmes, William H. The Use of Gold and other Metals among the Ancient Inhabitants of Chiriqui, Isthmus of Darien. Pp. 27. Pilling, James Constantine. Bibliography of the Eskimo Language. Pp. 116. Bibliography of the Siouan Languages. Pp. 87. Henshaw, Henry W. Perforated Stones from California. Pp. 84. Washington: United States Bureau of Ethnology.

Hazen, W. B. Report of the Chief Signal-Officer for 1886. Washington: Government Printing-Office. Pp. 500.

Goode, George Brown. The Fisheries and Fishing Industries of the United States. Vol. II. Geographical Review for 1880. Washington: Government Printing-Office. Pp. 787.

Stockwell, C. T. The Evolution of Immortality. Chicago: Charles H. Kerr & Co. Pp. 69. $1.

Seiler, Emma. The Voice in Singing. Philadelphia: J. B. Lippincott Company. Pp. 192.

Schurman, Jacob Gould. The Ethical Import of Darwinism. New York: Charles Scribner's Sons. Pp. 264. $1.50.

Camp, C. C. Labor, Capital, and Money: Their Just Relations. Bradford, Pa.: D. W. Leech. Pp. 250.

Halliwell-Phillips, J. O. The Works of William Shakespeare, in reduced fac-simile, from the First Folio of 1623. New York: Funk & Wagnalls. Pp. 926. $2.

Morgan, Mary. Poems and Translations. Montreal: J. Theodore Robinson. Pp. 195.

Gordon, Anna A. The White Ribbon Birthday Book. Chicago: Woman's Temperance Publishing Association. Pp. 278.

Lindley, Walter, M. D., and Widney, J. P., M. D. California of the South. New York: D. Appleton & Co. Pp. 377. $2.

Salomons, Sir David. Management of Accumulators and Private Electric Light Installations. New York: D. Van Nostrand. Pp. 150, with Plate.

Oliver, John A. Westwood. Astronomy for Amateurs. London and New York: Longmans, Green & Co. Pp. 316. $2.25.

Kinney, Coates, Xenia, Ohio. Lyrics of the Ideal and the Real. Pp. 140.

Kansas Academy of Science. Transactions, 1885-'86. Topeka: Kansas Publishing House. Pp. 155, with Plates.

Müller, F. Max. Biographies of Words and the Home of the Aryas. New York: Longmans, Green & Co. Pp. 278.

Ballou, Maturin M. Under the Southern Cross. Boston: Ticknor & Co. Pp. 405.

Saint-Pierre, Bernardin de. Paul and Virginia. Translated by Clara Bell. New York: W. S. Gottsberger. Pp. 219.

Rueta, Emily. Memoirs of an Arabian Princess. New York: D. Appleton & Co. Pp. 307. 75 cents.

Bain, Alexander. On Teaching English. Pp. 256. $1.25. English Composition and Rhetoric. Pp. 348. New York: D. Appleton & Co. $1.50.

Morrison, Gilbert B. The Ventilation and Warming of School-Buildings. New York: D. Appleton & Co. Pp. 173. 75 cents.

Wilson, James Harrison. China, with a Glance at Japan. New York: D. Appleton & Co. Pp. 376. $1.75.

Beecher, Henry Ward. Patriotic Addresses in America and England, from 1850 to 1885. New York: Fords, Howard & Hulbert. Pp. 837. $2.75.

Patton, Jacob Harris. Natural Resources of the United States. New York: D. Appleton & Co. Pp. 529. $3.

Day, David T. Mineral Resources of the United States. Calendar Year 1886. Washington: Government Printing-Office. Pp. 813.

Bancroft, Hubert Howe. History of the Pacific States of North America. Mexico: Vol. VI, 1861 to 1887. San Francisco: The History Company. Pp. 760. $5.

Muybridge, Eadweard. Animal Locomotion. An Electro-Photographic Investigation of Consecutive Phases of Animal Movements. Philadelphia: J. B. Lippincott Company. 100 Plates. $100.

Bishop, George R., New York Stock Exchange. Exact Phonography. Pp. 244. $3.

POPULAR MISCELLANY.

The Panama Canal.—At the meeting of the Academy of Sciences held in Paris, January 9, 1888, M. Ferdinand de Lesseps made a communication in relation to the proposed changes in the Panama Canal, of which the following account is taken from the "Journal des Débats": "What is now being done—and this will enable the largest vessels to pass from one ocean to the other in 1890—is the ship-canal just as it was agreed upon by the International Congress, and just as it should be on the original line; only, instead of waiting until it shall be completely finished, in order to open it to navigation, we have simply decided to do again that which was considered best for the Suez Canal in 1865—that is, at a time when formidable opposition, both political and financial, particularly financial, threatened to ruin the enterprise just as it was about to be finished. We have merely decided to open the canal to navigation as soon as possible when we shall be able to have ships as large as those of the Transatlantic Company pass from one ocean to the other, and a sufficient number of them to bring the annual traffic up to seven and a half million tons, as was predicted by the International Congress. This traffic assures us an annual revenue of one hundred and twenty million francs; it will enable us to settle all our indebtedness, and to pay a first dividend on the shares, and will still leave us something over. It is just as this surplus will increase that we shall complete the canal without any one feeling the expense, and without stopping the regular increase of the dividends, exactly as has been the case at Suez. But, in order to open the Panama Ship-Canal to the navigation of large vessels before it is finally completed, the problem is to hold the water in the parts of the canal not yet dug to the requisite depth in what engineers call upper basins ("biefs supérieurs"); to hold the water there, and at the same time allow ships to pass in and out of these basins, we shall have to construct metallic doors as for locks, like those seen in all harbors where there is a rise and fall of the tide, and in ocean harbors. Mr. Eiffel, at my request, is to take charge of this work, for

which his experience, his scientific knowledge, and the great works of this kind he has undertaken and always succeeded in, naturally pointed him out beforehand as my assistant. That is the whole story. So, it is the future tide-level ship-canal at Panama that will continue to be dug; it will be laid out in a way to accommodate the traffic of the world, and be continued and completed much sooner than is supposed, although the traffic of seven and a half million tons calculated by the International Congress is actually more than ten million tons. The profits will soon be great enough to enable the canal to be finally completed with little delay, and at no further expense, as it will pay for itself."

Opinions about the Mound-Builders.—In explaining the methods of the Bureau of Ethnology in mound-exploring, Dr. Cyrus Thomas mentions three plans on which the work might be done that are worthy of consideration. The first is the systematic plan, under which all the ancient works should be surveyed and mapped, and then thoroughly explored and investigated; the second is the local plan, which begins with a limited locality and confines operations to it until the investigation of it is completed; and the third is the comprehensive plan, or plan of general study, in which the chief objects are to search for and study the various forms and types of the works and minor vestiges of art, and to mark out the different archæological districts as disclosed by investigation. This plan permits the carrying on of operations at various points simultaneously, or removal from place to place as the types and forms of a section are satisfactorily determined. The first of these plans is regarded as the most systematic and scientific, and the second as next so. Yet circumstances have made it expedient for the Bureau to adopt the third, which promised to yield the results that were most immediately demanded, more expeditiously and at less cost than the others. The question most prominently kept in view was that whether the mound-builders were Indians. From the data so far obtained, the conclusions appear to be justified that the mound-builders, in the area to which especial attention has been given, consisted of a number of tribes or peoples bearing about the same relation to one another and occupying the same culture status as the Indian tribes inhabiting the country when it was first visited by Europeans; that nothing trustworthy has been discovered to indicate that these tribes belonged to a highly civilized race, or that they were a people who had attained a higher culture status than the Indians; that the links discovered directly connecting the Indians and mound-builders are so numerous and well established that there should be no longer any hesitancy in accepting the theory that the two are one and the same people; that the statements of the early navigators and explorers as to the habits, customs, circumstances, etc., of the Indians when first visited by Europeans, are largely confirmed by what has been discovered in the mounds and other ancient works of our country; that the evidence obtained appears to be sufficient to justify the conclusion that particular works and the works in certain localities are to be attributed to particular tribes known to history; that the testimony of the mounds is very decidedly against the theory that their builders were Mayas or Mexicans; and that evidences of contact with Europeans are frequent and authentic enough to make it probable that a goodly number of the mounds were built subsequently to the discovery of the continent by Europeans.

Some Advantages of a Fruit-Diet.—"Fruit and Fruit-Culture, as related to Health," was the subject of an address by Professor H. W. Parker before the Iowa State Horticultural Society, in which working among fruit and living with it are commended to a population who become bilious on excess of meat. In temperate zones, the author says, "the dire experience of almost universal disease, and the evidence of those who have freely used fruit, point to this as a most needful article of diet; and when we come to the tropics we find that men must confine themselves mostly to fruit-diet, a practice that should be largely followed in our long, hot summers; yes, with our present habits of unwholesome living, especially in respect to confined air and cooking, must be observed in winter as well. In the warm temperate climates there are enough exam-

ples of muscular, long-lived people who live on a minimum of animal food, such as those of the Grecian Archipelago, who subsist on goat's milk, figs, and maize-bread. Individual examples are to the same effect. Dr. Winship began as an invalid, and by athletics and diet attained such vigor that he could lift twelve hundred pounds. He indulged, we are told, occasionally in sardines, and for the rest depended on fruit and farinaceous (that is, starchy) food. The recovery of health in grape-cures shows what may be sought in that direction; the peach-cure has lately come into notice, and doubtless any ripe, fresh, juicy fruit, if not of a kind too astringent or laxative in certain cases, would do as well. I can testify that a quart or two of strawberries, twice or thrice a day, soon recovered me from torpidity of the liver and consequent constipation, increasing for a year or two; and yet this is spoken of as not of an aperient sort. Since then my only medicine is fruit the year round."

Thrifty Habits of a Woodpecker.—Not many observations have been recorded of the laying up of food for future use by birds. One woodpecker, in California, is known to deposit food by digging holes in the trunks of trees and driving acorns into them till the trunks look as if they were studded with brass nails. Professor O. P. Hay observed a similar trait in the red-headed woodpecker during an unusually favorable season for beechnuts in Indiana. "From the time the nuts began to ripen," he says, "these birds appeared to be almost constantly on the wing, passing from the beeches to some place of deposit. They have hidden away the nuts in almost every conceivable situation. Many have been placed in cavities in partially decayed trees; and the felling of an old beech is sure to provide a little feast for a bevy of children. Large handfuls have been taken from a single knot-hole. They are often found under a patch of the raised bark of trees, and single nuts have been driven into cracks in bark. They have been thrust into the cracks in front gate-posts; and a favorite place of deposit is behind long slivers on fence-posts. I have taken a good handful from a single such crevice. . . . In a few cases grains of corn have been mixed with beechnuts, and I have also found a few drupes, apparently of the wild-cherry, and a partially eaten bitter-nut. The nuts may often be found driven into the cracks at the end of railroad-ties; and, on the other hand, the birds have often been seen on the roofs of houses, pounding nuts into the crevices between the shingles. In several instances I have observed that the space formed by a board springing away from a fence-post has been nearly filled with nuts, and afterward pieces of bark and wood have been brought and driven down over the nuts, as if to hide them from poachers. These pieces of bark are sometimes an inch or more square and half an inch thick, and driven in with such force that it is difficult to get them out. In one case the nuts were covered over with a layer of empty involucres. Usually the nuts are still covered with the hulls; but here and there, when the crevice is very narrow, they have been taken off, and pieces of the kernels have been thrust in."

Alaska and its Tundra.—A contributor in the "American Field" describes Alaska as having dimensions not only in latitude and longitude—"for not a great distance from the Aleutian Islands, separating the Pacific from Behring's Sea, and in the former body of water we have the deepest sea-soundings known to science, while Mount Saint Elias cleaves the clouds for 19,500 feet, the highest mountain of the North American continent, and the highest Alpine peak in the whole world; for the line of perpetual snow and ice starts at its very base and covers it throughout except where buttresses of bare rock and pinnacles of perpendicular stone jut through the frozen mass, because they are too steep for the snow and ice to rest upon. . . . If we look at a map of Alaska we will see that fully a third of it is above the Arctic Circle, and the climate and other characteristics of this part are truly Arctic. The thermometer falls so low in winter-time that even the short, squatty Eskimo does not have to crane his neck to read the scale; the ground is frozen for numberless feet below the surface, while nothing grows on that surface except the hardy polar mosses that form the marshy covering for the vast tundra for

which the Arctic flatlands are so well known. This marshy condition is produced every summer by the deeply-frozen ground thawing but a foot or two under the never-setting sun of that season, the deeper strata of ice remaining to act as an impervious shield to prevent the water from draining through, and on the prairies it remains as ice-water, surrounding the hardy mosses that thrive in it, and into which a traveler will sink up to his knees in the worst parts. A few stunted willows grow along the sluggish streams, but otherwise everything is bare of all except the moss. On this moss graze many herds of reindeer that roam with the wind and migrate backward and forward with the seasons." These reindeer furnish the Eskimos of the north and the Indians of the Yukon River with their meat and warm clothing.

Iridescent Clouds.—Mr. J. C. McConnel has studied the phenomena of iridescent clouds at Saint Moritz, Switzerland, where they are very common in winter, occurring usually whenever there are scattered clouds near the sun. Within a circle of about 2° radius, he says, the clouds are white, faintly tinged with blue. This space is surrounded by a ring of yellow or orange. The region of most vivid hues is comprised between 3° and 7°, and the most striking tints are purple, orange, green, and red. These colors are not arranged in rings, but are distributed over the thinner parts of a cloud in irregular patches. Beyond this region the only colors visible are green and red, which become fainter as the distance from the sun is increased. The author has detected them in a few cases at a distance of 21°. At some distance from the sun the greens and reds are frequently arranged in bands parallel to the edge of the cloud. The author supposes these colors to be the result of diffraction of light by fine particles of ice. The particular color assumed by any part of the cloud is determined by the distance from the sun and the average size of the particles. The particles are supposed to be in the form of thin hexagonal prisms, that being the shape among the known forms of ice-crystals best adapted to produce diffraction. Mr. McConnel calculated the probable diameter of the filaments, and found it to be between ·017 and ·009 millimetre for the purple, ·021 to ·010 millimetre for the orange, and ·014 to ·009 millimetre for the blue. The absence of the colors from clouds composed of water-particles is accounted for by the want of uniformity of size in the water-drops.

Accumulations of Atmospheric Dust.—Ruins of ancient cities and buildings are nearly always found wholly or partly buried. The material with which they are covered has been supposed to originate in the *débris* of buildings that have been erected and human works that have been going on upon their sites, but this can not always, or seldom wholly, be the case; for the same fact appears in desert and wilderness sites. Much is possibly due to superficial disintegration and the work of vegetation; but still another factor, more effective than has heretofore been supposed, may be sought in the deposition of atmospheric dust. In a note on this subject, read by him before the Geographical Society of Paris, M. Violet d'Aouest referred to Richthofen's account of a vast aërial formation of loess in China, and described his own observations in Mexico, where he found on the flanks of the highest mountains argillaceous strata not deposited by waters nor by the decomposition of the rocks; but investigation showed that they were produced by dust raised by the winds from the plains and deposited on the hills. These deposits varied from one hundred feet to—in some places—more than three hundred feet in thickness. They grow finer and finer as the height increases, and cease at the limit of vegetation.

Results of Nerve-Shock.—Many persons who experienced the earthquake in the Riviera have since suffered seriously from nervous shock, although they did not at the time appear to be greatly disturbed. This indicates that more injury may be done to the nerves by an undue excitement than is perceived at the time. The nerve-centers may, as an English medical journal suggests, be likened to batteries, and regarded as apt to be discharged suddenly and sometimes unconsciously; and when once their residual stock of energy is consumed, it can be restored only after a long time and by the

exercise of extreme care. It is practically observable that when nutrition is impaired in a nerve-center or branch, extreme difficulty is met in restoring the integrity of the nervous function, and even the wear and tear of ordinary life seems to increase the exhaustion instead of reducing it by stimulation of the recuperative faculty.

Handiwork - Teaching in Swedish Schools.—Slöjd is the Swedish name for handiwork instruction in the schools. It was invented by the famous Finnish educator Uno Cygnæus, and was adopted in Sweden about fifteen years ago. The teaching is confined to simple work in woods, if it is regarded merely as a training for the faculties, or in many branches if it is to be regarded as subsidiary to technical instruction. No efforts are spared to make the system attractive to pupils and parents. Pupils are allowed to keep what they have made, or to buy it cheaply; or are credited with deferred pay, which they forfeit if they leave before a stipulated course is completed, or which is given them as credits in a bank-book on finishing the course. The sympathy of parents is catered to by teaching the children to make and use such common implements as are most in demand at home; and by allowing them the use of the school-tools to make family repairs. The system has proved very successful in Sweden, Norway, and Finland.

Protection of Building - Stone.—All methods of protecting building-stone against decay depend upon filling the pores of the stone with some substance that shall exclude water, the vehicle by which acids are introduced. This is easily done while the builders are handling the stone, but it is very hard after the structure has been set up to paint on the water-proof material so as to insure its absorption to any considerable depth. Several processes including the use of silicate solutions have been described by Mr. W. G. Dent as having been used with more or less of success. Oxalate of alumina applied to limestones gives them a coating of the insoluble double oxalate. Organic substances like linseed-oil give considerable protection for a time, but are ultimately oxidized. Among inorganic or mineral substances paraffine has been used, as upon the obelisk in Central Park, with a degree of success; but the objection holds against its application that the stone has to be warmed to secure a sufficient depth of absorption. The obelisk on the Thames Embankment, London, has been treated with a preparation of solution of gum-resins in petroleum-spirit. But, Mr. Dent says, "if care be taken in the selection of the stone, it is only under special and exceptional circumstances that it will be considered desirable to resort to methods of preservation which must necessarily be expensive, and can only be regarded as the best cure for defects that admit of no other remedy."

The Wild Cattle of New Zealand.—The New Zealand farmers lost great numbers of cattle during the Maori wars which ended in 1868, through their being turned loose by the enemy and by other accidents incident to a season of disorder. These animals and their descendants now roam wild in the bush, particularly on the North Island, where they afford a sport "that is little less exciting and dangerous than that which exists in South Africa and the Western prairies of America." They are exceedingly difficult to reach, on account of the character of the bush around which they hover, which is composed of the long, twining creeper known as "supple-jack." No horse will try to penetrate this bush, because the instinct of the animal tells him that he will get his feet and legs entangled in the vines. "Not so, however, the wild cattle; they will, when surprised, rush madly into the densest shrubbery, and seem fully aware that nothing can possibly follow them into it; and it is thus that instinct has induced these cattle to bid defiance to man, and to live their primitive life over again."

Various Kinds of Soap.—According to a lecture by Dr. Stevenson Macadam, the remains of a well-organized soap-factory have been found in the ruins of Pompeii. Soap-factories existed in Italy and Spain in the eighth and in France in the ninth centuries. The manufacture in Great Britain is first heard of in the fourteenth century. White soap is generally prepared from tallow, with a little lard and palm-oil. In yel-

low soap resin is added. Soft soap is prepared from fatty substances, with potash. Cocoanut-oil soap has the advantage of being usable with sea-water, and is often called marine soap. Carbolic-acid soap contains about two per cent of carbolic acid, and has antiseptic as well as washing properties. In toilet soaps, as in old brown Windsor, when they are kept for a long time, the soda is influenced by the air and has its strong properties neutralized. Then it is remelted and stored up again, and remelted a second time, when it becomes soft and tender; but the toilet soaps of the present are not always given time to age. Pears's soap is ordinary soap of good quality, cut into shavings, dried, and treated with alcohol. The alcohol evaporates and leaves the transparent soap. The treatment has the effect of taking all the free soda out of the mixture.

Genesis of "Original" Rocks.—Dr. T. Sterry Hunt gave, in the British Association, a concise account of his theory of the genesis of the various groups of original or non-clastic rocks, which he classifies on the basis of their geognostic relations as indigenous, exogenous, and exotic masses. The superficial portion of a cooling globe, consolidating from the center from a condition of igneous fusion, he conceived to have been the protoplasmic mineral matter, which, as transformed by the agencies of air, water, and internal heat, presented a history of mineralogical evolution as regular, as constant, and as definite in its results as that seen in the organic kingdoms. The author next considered the conditions of softening and displacement of indigenous rocks, which permitted them to assume in many cases the relations of exotic rocks, and to become extended after the manner of lavas, as seen in the case of trachytes and many granite-like rocks. Such masses he designated pseudo-plutonic.

Efficiency of Explosives.—It is pointed out by Professor Charles E. Munroe, in his "Notes on the Literature of Explosives," that the theoretical efficiency of an explosive "can not be realized in useful work for several reasons, viz.: because of incomplete explosion; because of the compression and chemical changes induced in the surrounding mineral; because of the energy expended in cracking and heating rock which is not displaced; and because of the escape of considerable quantities of the gases through the blast-hole and the fissures made by the explosion. In all probability the extent of these losses can never be determined by direct experiment, as the phenomenon of an explosion does not admit of a close observation; nor can it be determined by comparison with the work done under other circumstances, as we are as yet uncertain as to the so-called dynamic resistance of rock. The useful work of a blasting charge is employed partly in shattering the rock and partly in throwing or displacing the shattered masses. It is a familiar engineering problem to reduce the projectile force of a blast to a minimum by means of suitable-sized charges, properly located in blast-holes of estimated dimensions, and so avoid the cannonading of which workmen are fond. With the discovery of at least approximately correct values for the useful work of charges, we are now able to demonstrate the correctness of this principle."

Mistakes in treating Organic Refuse.—Most of the shortcomings of modern sanitary methods, says Dr. G. V. Poore, are due to the fact that, in our dealing with organic refuse, we commit a scientific error—i. e., we pursue a course that is in opposition to natural law. This error consists in mixing organic refuse with water. It then undergoes changes which differ widely from the changes which it undergoes when mixed with earth. According to Wollny, the process of oxidation of organic matter and the formation of nitrates take place most readily when a moderate amount of moisture is present, and the most favorable amount is about thirty-three per cent. When water is in excess, the amount of free oxygen is insufficient to favor the growth of mold-fungi, the schizomycetes (bacteria and micrococci) are formed, and, in place of oxidation, putrefaction occurs, with the formation of ammonia, free nitrogen, carbonic acid, and carbureted hydrogen. This process of deoxidation takes place in mixtures of putrescible matter with water, and takes place also, it is said, in soil which is thoroughly soaked in sewage. In

the face of these facts, it is not to be wondered at that "sewage farming" has not proved a commercial success. We must, indeed, be in doubt whether, when the circumstances are more than usually unfavorable, it exercises any very great purifying action upon the putrescible mixture. In the treatment of putrescible refuse we have to aim at nitrification rather than putrefaction, and it is certain that by mixing with water putrefaction is encouraged and nitrification delayed. It seems to be almost incontestable that the proper course to pursue with regard to organic refuse—putrescible matter—is the very reverse of what we do pursue. We clearly ought to encourage oxidation and make putrefaction impossible. Putrefaction is certainly a great cause of ill-health. The putrefaction of organic refuse when mixed with water has, Dr. Poore thinks, been the chief cause of the development of modern sanitary progress—that is, of the need of doing something. Our forefathers were not given to this method of treating putrescible matter. House-slops trickled along open gutters, and excremental matters were deposited in dry pits.

Cameo-cutting for Amateurs.—Mrs. Henry Mackarness, in her "Young Lady's Book," represented cameo-cutting as an art simple enough to be acquired without great difficulty, which would "give young ladies a new and elegant pursuit." Only two kinds of tools are used, which are named the scawper and the spit-sticker. The work is performed at a bench or table, furnished with suitable gripping apparatus, the shell being fixed with setter's cement on a stick, which may be made of a five-inch section of a broom-handle. Care should be taken to select a piece of shell without a flaw. Beginners should choose tolerably smooth pieces; but practiced workers prefer those which are irregular in their surface, because they furnish more scope for the exercise of skill. In cutting these the design follows the convolution of the shell. Care must be taken in cutting not to let the ground show through; but a skillful cutter will so arrange his design as to produce the blush of the ground in such portions as to enhance the value of his work. Shells are further liable to the faults of displaying crooked lines in the cutting, which are believed to have been the work of worms in the earlier stages of their development, and of "flaking." Beginners will draw the figure before attempting to cut; but a skillful operator will cut away at once, and rough out the head and face of a portrait very quickly. A workman can cut a portrait from a photograph in a few hours. The beginner should not spend more than two hours at a single sitting. In beginning, the learner should cut a few simple outlines, such as are furnished by the rose, the lily, or the fuchsia; the hand soon becomes accustomed to the use of the tools, and the timid cut becomes exchanged for the vigorous and graceful stroke of the artist. Great care is necessary in working the shell so as not to cut into the ground, on account of the extreme difficulty of removing any marks. Marks are removed by the use of powdered pumice-stone and water, applied on a piece of pointed wood; the next process is to smooth the surface with pumice-stone and oil; wash with a soft brush and warm water, then polish with the dust of the rotten-stone and sulphuric acid, mixed to a paste, and applied on the point of a piece of wood.

Vaccination and Erysipelas.—A report by Dr. Airy, on three cases of so-called fatal erysipelas after vaccination, will help in forming a judgment of the sort of foundation on which the fears of an outcome of this character rest. The three children were vaccinated by three different practitioners. In the first case the erysipelas set in too late for it to be possible for vaccination to have had anything to do with causing it; in the second case the child was surrounded with erysipelas in the surgery where it was brought to be vaccinated; in the third case no definite source of erysipelatic infection could be discovered, but the child lived in a low-lying place, close to swampy and unhealthy meadows. Thus, none of the cases were traceable to the vaccine lymph; and its innocence is attested by the fact that other children were vaccinated with the same lymph without the occurrence of untoward symptoms. The question arises next as to the degree of danger of erysipelas entering the vaccination-scratch, or the wound left by a ruptured

vesicle, the same as it might any other wound. According to statistics presented by Dr. Buchanan, the proportion of such accidents that occurred in England and Wales during 1883 was 51 infants dying of septic disease out of 763,192 vaccinated.

Lime-Salts in the Food and the Teeth.—Dr. W. D. Miller, of Berlin, has been making experiments to determine how far changes can be produced in teeth by the presence or absence of lime-salts in food. His method is to extract a tooth from a healthy dog, and then to feed the animal upon food containing but little lime-salts for three months; then to remove a second tooth, and change the food to one containing an excess of salts. After four months of this treatment another tooth is extracted. The author has found that an appreciable loss of lime-salts occurs in the first stage, which amounts in one case to more than one per cent, and that the proportion of lime-salts rises again to normal during the second stage.

The Making of Britain.—In studying, by geological evidences, the changes which have taken place in Great Britain since it was first inhabited by man, Professor Archibald Geikie goes back to the time when it was not yet an island, but formed a part of the European Continent. Its separation occurred by gradual subsidence, in which the chalk ridge between Dover and Calais was the last landmark to disappear; and "along this narrow ridge the earliest Celtic immigrants may have made their way." It was probably finally washed away as much as sunk. At the dawn of history, the general appearance of the country must have been characterized by wide-spread forests, abundant bogs and fens, and a profusion of lakes; and at the first coming of the Romans the greater part of the country was probably covered with wood. Large tracts of these woods persisted for many hundred years, and as late as the twelfth century the woods to the north of London swarmed with wild boars and wild oxen, and the woods everywhere were the resorts of broken and desperate men. In the course of generations the wood and open land have largely changed places. The belts of clay soil, originally the most heavily timbered tracts, proved admirably adapted to agricultural purposes and were cleared for cultivation, while the open places, with their light soils, were abandoned, to become wastes of scrub and copsewood. Great topographical changes have been wrought by the disappearance of the fens and bogs. Some have been naturally silted up, and others have been artificially drained; while their sites are still indicated by such Saxon names as Bogside, Bogend, and Mossflats; and by the black, peaty soil which marks where they once lay. No one would be led to suspect by the examination of modern maps the number of lakes that once dotted the north of England and Scotland; but inspection of old maps will show many sheets of water that do not now exist, or are much reduced in size. Topographical names will reveal the sites of other and sometimes still older lakes, while geological evidence will tell of others of which there is no human record. Other changes have been and are going on along the shore, where the land is washed away at some places and added to at others. All these things are subjects for profitable study, and call for it; and we may add that similar changes are going on and invite attention in the United States. Their progress is much more rapid than any one could suppose till he begins to make it the subject of careful observation.

The Ruby-Mines of Burmah.—The ruby-mine tract in Burmah, according to Mr. G. Skelton Streeter's description in the British Association, is a large valley some twelve miles long by eight miles broad, and composed of several small valleys, or rather basins. It lies on the slope of the Sibwee Doung, which divides the Irrawaddy and Salwen Rivers. The valley bears signs of volcanic origin. The mines are of three distinct kinds. The first is furnished by the metamorphic rock, whose mass is traversed in all directions by huge fissures, caused probably in the past by shrinkage. These fissures are filled with a soft, clayey earth, generally containing rubies. At present they are worked in a very superficial manner. The mines of the second variety are on the sides of these rocky hills, where diversified strata of clayey consistency have

been upheaved. The natives wash this earth slowly away by hydraulic mining. The third system of mining is by sinking pits in the lower or plain parts of the valley, and washing the earth extracted by hand.

Effects of an Earthquake.—A paper was read in the British Association by Dr. T. Sterry Hunt and Mr. J. Douglas, describing their observations of the effects of an earthquake which took place in Sonora, Mexico, on May 3, 1887. The authors found the results of the undulatory movements of the soil apparent in the San Pedro and Sulphur Spring Valleys in great numbers of cracks and dislocations. For distances of several hundred feet, sometimes with a generally north and south course, vertical down-throws on one side of from one foot to two feet were seen, the depressed portion rising either gradually or by a vertical step to the original level. Branching, and in some cases intersecting, cracks were observed. These depressions were evidently connected with outbursts of sand and water, which, along cracks—marked by depressions on both sides—sometimes covered areas of many hundred square feet with layers a foot or more in depth, marked here and there by craters, two feet in diameter, through which water had risen during the outburst of these volcanoes.

Agassiz's Service to Evolution.—Professor Le Conte's ascription to Professor Agassiz of the credit of having laid the basis for the doctrine of evolution is confirmed, from a different point of view, by Professor Alfred Newton, in his opening address before the Section of Biology of the British Association. The speaker, referring to Agassiz's doctrine of centers of creation, said that "creation in his mind was no figurative expression. He meant by it . . . a direct act of God—in other words, his belief was, that there had been going on around us a series of mysterious performances, not one of which had ever been consciously witnessed by a human eye, each of which had for its object the independent formation of a new living being, animal or plant." This doctrine of a continuous series of miraculous acts having gone on for an indefinite time was perfectly logical when the premises were admitted; and it became obvious that the alternative was between that doctrine and the theory of transmutation of species. The having made this thought clear is declared by Professor Newton to have been a great service rendered to the new theory by one who was its most determined opponent.

A Floral Moth-Trap.—Mr. Robert E. C. Stearns, in the "American Naturalist," describes the plant *Araujia albens* as a "moth-trap." The plant, formerly called *Physianthus*, is a native of Buenos Ayres, but has been pretty widely distributed in the United States, and may be found now at places as far apart as Boston and San Francisco. The insects are caught in the flower, which is trumpet-shaped, flaring at the mouth, where the petals divide, and then uniting and forming a tube, which is swollen into a bulbous form where the corolla joins the calyx. The stamens are furnished with side wing-like processes and exterior spurs, which press against the gynœcium, and hide the ovaries and pollen-masses. "The moth, in pursuit of the nectar, first reaches that portion contained in the pockets between the bases of the spurs; then, in search of more, having already thrust the proboscis down the tube of the flower, describing a curve between the exterior of the stamineal crown or mass and the inside of the bulb of the perigonium, it has to push the proboscis upward in order to reach that portion of the flower where the anther-cells, pollen-masses, and glands are in close juxtaposition." Having satisfied its hunger, or otherwise, upon attempting to withdraw the proboscis by a direct pull—which it can not do, because the organ is not provided with any muscular arrangement by which the curved motion made in entering can be reversed—the proboscis "becomes wedged in between the edges of what may be termed the anther-wings, or rather the edges thereof, and is held tight, very much in the same way that an old-fashioned boot-jack grips a boot. The more the moth pulls, the tighter or firmer the grip, and escape is impossible, unless the flower has reached such a degree of maturity that its substance has become somewhat softened or wilted."

Disinfection by Heat and by Steam.—Dr. H. F. Parsons has found, in experiments on the disinfection of packages by heat and by steam, that dry heat at the boiling-point for an hour is sufficient to destroy active bacilli of all ordinary infectious diseases; but, if spores are to be attacked, a heat of 245° for an hour or of 220° for four hours will be required. The complete penetration of an object by steam-heat for more than five minutes is sufficient for its full disinfection; and this method is applicable to such articles as pillows, which are very difficult of penetration to dry heat. Moistening the air of the heated chamber diminishes the time necessary for penetration, while it also makes the distribution of temperature through the chamber more agreeable, and tends to prevent the scorching of articles placed in it; but it was not found to increase the disinfecting power at the temperature employed. Damage may be done to articles in disinfecting them by heat or steam, by scorching or partial decomposition of organic substances; by fixing of stains; by melting of fusible substances; by changes in color, gloss, etc.; by shrinking and felting of woolen materials; or by wetting. The nature of the articles should, therefore, be regarded in adapting the process to them.

English Taxes.—The first recorded tax imposed upon Britain was laid by Julius Cæsar, who, after his victories, required for Rome an annual tribute of men and wild animals—the men to be kept as hostages, the animals to be fought with in the arena. When ecclesiastical domination came in, the Pope levied a "Peter's pence" for the support of his English University at Rome. When the English conquered Wales, they levied on the people an annual tax of three hundred wolves' heads, which proved a great blessing to the principality. After England became exposed to great danger from the incursions of the Northmen, a land-tax of twelve pence per "hide" was levied in order to raise a sum with which to buy off the invaders. The consequence of this silly policy was that more invaders came to be bought off. A poll-tax was imposed in the fifteenth century of one shilling a year upon every person, except he belonged to the clergy, above the age of fifteen years. This was distasteful to the people, and led to rebellion. In another form of taxation, laborers and tradesmen were required to give their services to the king or to a noble. Many palaces, Windsor Castle among them, were built in this way. From 1695, for thirteen years, every person not a pauper was required to pay a tax for each child born to him, rising from two shillings in the case of a common person to thirty pounds in the case of a duke. A bachelor's tax of one shilling in the case of ordinary persons was imposed on unmarried men over twenty-five years old, and on widowers without children, but wealthy people and nobles had to pay more. By Queen Elizabeth's act of uniformity, persons who refused to become Episcopalians, or who absented themselves from church on Sundays, had to pay a tax of a shilling a year. Perhaps the most oppressive and impolitic taxes imposed by the British Government were those on windows and on funerals, with which even the history of this nineteenth century has been blotted.

NOTES.

THE second ten days of January were extraordinarily cold all through the Northwest, and temperatures were registered at some places much below what had ever before been observed in the United States. At Iowa City, according to Professor Hinrichs, the mercury was at or below zero every night from the 11th to the 20th. During the twenty-eight years that weather observations have been taken, there have been only five decades having a mean temperature of zero or below; only one of these was during the first eighteen years, while the other four were during the last ten years. This shows that extreme cold has been seven times more frequent during the latter than during the former years, and is another indication of what the author has often held, that the later winters in Iowa have been colder than the former ones.

A "CABLE anchor" has been successfully tried in the Seine for stopping boats. The apparatus is a cable, having on it a series of canvas cones, which open out by the action of the water, and close again when drawn the usual way. A steamer running thirteen knots was stopped each time by the apparatus in thirteen seconds, and in a space of from twenty to thirty feet.

PROFESSOR MUSHKETOFF describes the effects of the operations of the marmots in modifying the surface of the Siberian steppes as important. Their heaps of earth cover hundreds of square miles, and each one of them represents at least two cubic metres of earth removed, or about 30,000 cubic metres brought to the surface on each square kilometre.

THE survey and last census of India show that the area of the peninsula of Hindostan is 1,382,624 square miles, and the population 253,891,821. Although immense tracts of country are annually cultivated, ten million acres of land suitable for cultivation have not as yet been plowed; and one hundred and twenty million acres are returned as waste lands.

M. JOVIS, Director of the Aëronautic Union of France, has found a satisfactory varnish for textile materials. It is described as being of great flexibility, as containing no oleaginous base, and, while adding little to the weight, as conferring great impermeability. It is well adapted for balloons, marine cordage, sails, tents, and similar structures; is suitable for paintings and wainscotings; is exempt from moldiness; can be exposed to very varied temperatures without alteration; and furnishes sub-products which can be utilized for coating walls, railway-sleepers, etc.

PROFESSOR W. MATTIEU WILLIAMS offers as a better explanation than the old one of the zigzag course of lightning, that owing to variations of moisture the conducting power of different portions of air is variable, and the electric discharge follows the course of least resistance.

EXPERIENCE at the Winter Palace of the Czar at St. Petersburg indicates that the electric light injures the exotic plants used for the decoration of the rooms by causing the leaves to turn yellow, dry up, and fall off. The experiments of Dr. Siemens led him to a different conclusion, but his greenhouse was heated by the waste steam from the engine driving his dynamo, and this perhaps was of beneficial effect sufficient to counteract the mischief done by the light.

AN effective composition for a "hand-grenade" fire-extinguisher is, common salt, 19·46; sal ammoniac, 8·88; water, 71·66; or 20 pounds of salt, 10 pounds of sal ammoniac, and 7 gallons of water. The flask should be of thin glass, so that when thrown with force against any object, it will fall to pieces. The grenades, costing but little, can be distributed freely all over the premises to be protected; and, should a fire occur, break a bottle or several bottles over it, and the disaster will probably be averted.

M. BONNAL has observed, by experiment, that hot baths induce a loss of weight caused by the sweating, which lasts for about twenty-four hours. It is compensated for by increased drinking and diminished urinary secretion. Baths of dry hot air provoke a sweat that ceases on coming out of the bath, while the perspiration provoked by warm-water baths and warm moist-air baths lasts frequently for an hour after the bath is over. The nervous incidents of the bath, such as the acceleration of the pulse and of respiration, make their appearance before the central temperature exhibits any elevation.

J. CHALMERS ROBERTSON, M. B., relates in "The Lancet" the case of a family whom he had attended, who were poisoned from eating bread in which mold had developed itself. Every member who had partaken of the loaf in ordinary quantity had been made ill; one member who had merely eaten a small piece, felt uncomfortable; those who did not eat any remained well. The symptoms were diarrhœa and pain in the epigastrium. The author suggests from this experience, that it is possible that we may have in undetected diseased bread an important factor in the causation of diarrhœa which we would not readily suspect.

PERSONS whose plants mysteriously sicken and die out, may learn from the experience of Dr. J. W. L. Thudicum, as related by him to the London Society of Arts. He watered a frame of flourishing young wall-flowers, the ordinary tap being dry, with water of at least suspicious purity from another tap. The plants were soon infected with a fungus, and in a short time the frame did not contain a healthy, hardly a living plant. For two summers the mignonettes in a conservatory were destroyed by a root-fungus which distorted the plants and made them sickly and short-lived. The only way in which this parasite could be got rid of was by destroying the earth and all wooden boxes by fire, and growing no mignonette in the conservatory for two years.

MR. MAIGNEN made last year a successful and satisfactory exhibition of his process for softening water by means of the material called "anti-calcaire." Steam-boilers which had already become slightly incrusted with lime, were worked for two years with water softened by anti-calcaire without attention. When opened, they were wholly free from incrustation, showing that the material had not only prevented the effect taking place, but had also destroyed what incrustations had already accrued.

A COLLECTION of specimens of poisonous fishes is shown in connection with the exhibition recently opened in Havre, France.

Some are poisonous when eaten; others are merely venomous. Among the first are many spheroids, a tetrodon, and many *Clupea*, which are abundant near the Cape of Good Hope. In the Japan Sea is found a very peculiar tetrodon, which is sometimes used as a means of suicide. It brings on sensations like those produced by morphia, and then death.

THE nervous irritation produced by tinnitus, or noises in the ear, from which many persons suffer much, has been mentioned as a possible cause of mental disorder. The coarser diseases of the ear are subject to surgical treatment from without; but nervous affections provoked by obscure disorders are not so amenable, because their causes are more subtle, although none the less real. Sometimes an obstruction of the eustachian tube may be the chief cause of tinnitus.

OBITUARY NOTES.

DR. ASA GRAY, the eminent botanist, died at his home in Cambridge, Massachusetts, January 30th, in the seventy-eighth year of his age, after an illness of about a month. He was born in Paris, Oneida County, New York, in 1810; studied medicine, and received the degree of M. D. in 1831, but never engaged in practice; became an assistant in the chemical laboratory of Dr. John Torrey in 1833; and a little later was appointed curator in the Lyceum of Natural History. His first botanical writings were descriptions of sedges and of certain plants of northern and western New York. In the "Elements of Botany," published in 1836, he showed that he had already views of his own, which he was not afraid to utter, even though they might be different from those of the then recognized authorities in science. From that time till the end of his life he worked with unceasing activity and growing fame, and for many years he has been recognized as one of the leading botanists of the world. His numerous works are well known to all readers and students, and can not be catalogued in a note. It is enough to say of them that whichever class of them we regard, they have never been excelled.

PROFESSOR T. S. HUMPIDGE, chemist of the University College of Wales at Aberystwith, died November 30th, aged thirty-four years. He prosecuted his earlier scientific studies while serving as a clerk in a corn-merchant's office, at the evening classes of the Science and Art Department, and afterward studied under Professors Frankland and Bunsen. His first publication was on "The Coal-Gas of the Metropolis." He investigated the atomic weight of beryllium, made redeterminations of the specific heats of various metals, and translated and edited Kobbe's "Inorganic Chemistry."

PROFESSOR BONAMY PRICE, Professor of Political Economy in the University of Oxford, died in London, January 8th. He was born in Guernsey in 1807; was one of the masters in Dr. Arnold's school at Rugby from 1830 to 1850; and was one of the recognized authorities in his special branch of research. His lectures, in their published form, have had an important economic influence. They include "The Principles of Currency" (1869), and "Chapters on Political Economy" (1878). In 1876 Professor Price published another work, "On Currency and Banking."

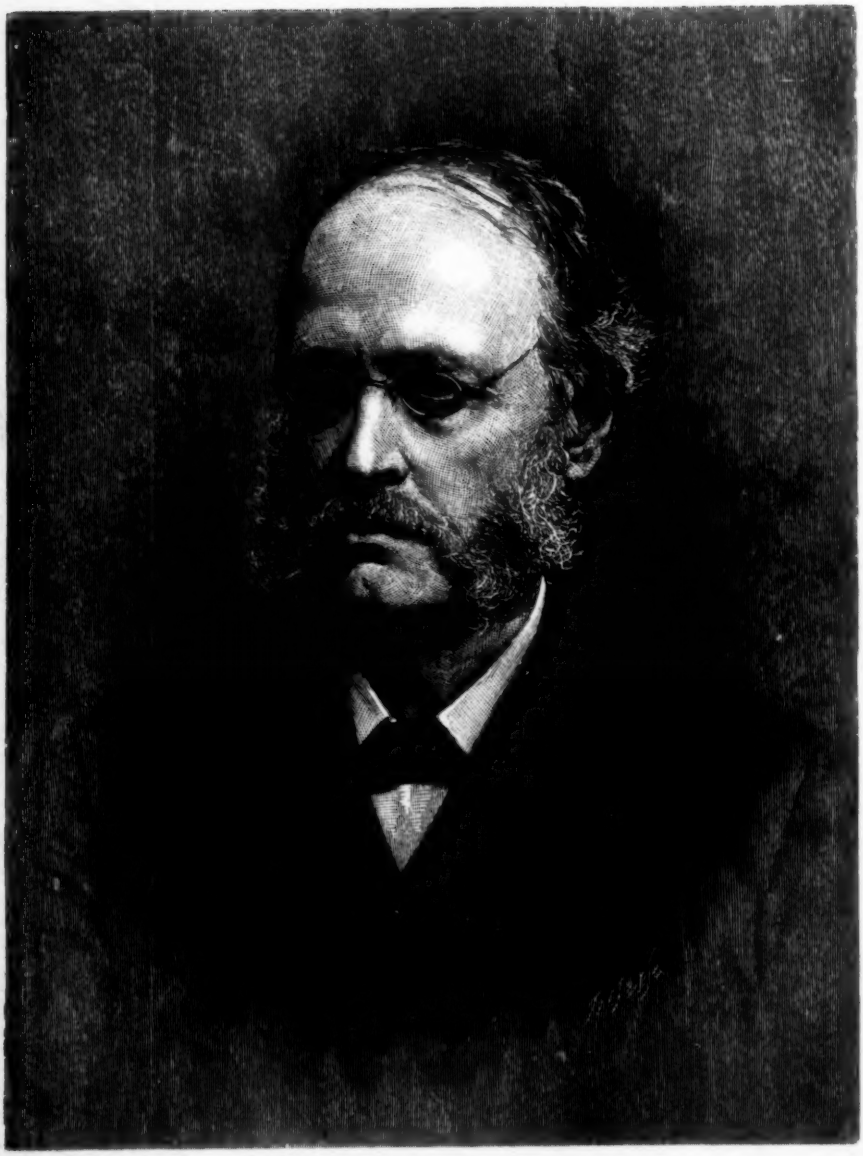
DR. CARL PASSAVANT, the African traveler, died recently at Honolulu, in the thirty-fourth year of his age.

DR. FERDINAND VANDEVEER HAYDEN, a geologist whose name is inseparably associated with the Government explorations of the Rocky Mountain region, died in Philadelphia, December 22d, after an illness of many months. He was born in Westfield, Massachusetts, in 1829, and was graduated from Oberlin College in 1850, and from the Albany Medical College in 1853. He was connected for more than twenty years, a great part of the time as chief, with the explorations of the Western Territories, including Kansas, Nebraska, Colorado, New Mexico, Dakota, Montana, Idaho, and Utah. Besides the official reports of his exploring work, he was the author of the books, "The Great West; its Attractions and Resources" (1880), and "North America" (1883). He was a member of most of the American scientific societies, and an honorary and corresponding member of many foreign societies.

M. F. J. RAYNAUD, an eminent French electrician and director of the Higher School of Telegraphy, died early in January, from the results of a murderous attack. He was associated with the laying of several telegraphic cables, one of which, crossing the Seine, having been broken, he repaired in 1870, in the face of the enemy's fire. He was the first person to call the attention of French men of science to the labors of Englishmen in electric unities; and he translated Gordon's "Treatise on Physics" into French.

THE recent death is announced of Professor Arthur Christiani, of the Physiological Institute of Berlin, who was a great authority on the physiological action of electricity, and on the physiology of the nervous system and of the sense of hearing.

DR. MAX SCHUSTER, an eminent petrologist, of the University of Vienna, died last November.



DAVID AMES WELLS.